Learning from Carchi

Agricultural Modernisation and the Production of Decline

Stephen G. Sherwood

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To Irene, Myriam, and
the people of Carchi

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Acronyms

AAE	Agro-Ecosystem Analysis
ANT	Actor-Network Theory
APRODIC	*Asociación de Promotores de Desarrollo Integrado de Carchi*; Association of Promoters for the Integrated Development of Carchi
APSCA	*Associación de la Industria de Protección de Cultivos y Salud Animal*; Association of the Industry of Animal and Crop Protection Products
CEA	*Coordinadora Ecuatoriana de Agroecologia*; Ecuadorian Coordinator of Agroecology
CIP	*Centro Internacional de la Papa*; International Potato Center
BBC	British Broadcasting Company
CBO	Community-based Organisation
CGIAR	Consultative Group of International Agriculture Research Centers
CIAL	*Comite de Investigación Agrícola Local*; Local Agriculture Research Committee
CIMMYT	*Centro Internacional para el Mejoramiento de Maíz y Trigo*; International Center for the Improvement of Maize and Wheat
COSUDE	*Cooperación Suiso al Desarrollo*; Swiss Cooperation for Development
DFC	*Desarrollo Comunitario Forestal de la* FAO; FAO's Community Forestry Programme
EESC	*Estación Experimental de Santa Catalina del* INIAP; INIAP's Santa Catalina Experiment Station
FAO	The United Nation's Food and Agriculture Organisation
FFS	Farmer Field Schools
FTA	US-supported Fair Trade Agreement
IDB	Inter-American Development Bank
IDRC	Canada's International Development Research Centre
IERAC	*Instituto Ecuatoriano de Reforma Agraria y Colonización*; Ecuadorian Institute of Agrarian Reform and Colonisation
IGM	*Instituto Geográfico Militar*; Military Geographic Institute
INAMHI	*Instituto Nacional de Meteorología e Hidrología*; National Institute of Meteorology and Hydrology
INEC	*Instituto Nacional de Estadísticas y Censos*, National Census and Statistics Institute
INIAP	*Instituto Nacional Autónomo de Investigación Agropecuaria*; National Autonomous Institute of Agricultural Research
IPM	Integrated Pest Management
IPM-CRSP	USAID's Integrated Pest Management Collaborative Research Support Program
LACPA	Latin American Crop Protection Association
MACRENA	*Red de Manejo Comunitario de los Recursos Naturales*; Network of Community-Based Natural Resource Management
MAG	*Ministerio de Agricltura y Ganadería*; Ministry of Agriculture
NAT	*Nucleo de Asistencia Técnica*; Nucleus of Technica Assistance
NGO	Non-Governmental Organisation

PAN	Pesticide Action Network
POP	Persistent Organic Pollutants
PPE	Personal Protective Equipment
PROMSA	*Programa de Modernización del Sector Agrícola*; Program for Modernisation of the Agriculture Sector
SESA	*Servicio Ecuatoriano de Sanidad Agropecuaria*, Ecuadorian Agricultural Health Service
SUP	Safe Use of Pesticides
ToA	Tradeoffs of Agriculture Analysis
UPA	*Unidad de Producción Agropecuaria*; Agricultural Production Unit
USAID	United States Agency for International Development
UVTT	*Unidad de Validación y Transferencia de Tecnologia del INIAP*; INIAP's Technology Validation and Transfer Unit
WHO	The United Nation's World Health Organisation

Glossary of Kichwa and Spanish terminology

arriezgados	a prestigious farming style characterised by a propensity for risk-taking
arrimado	member of the extended family of the *wasipungero* who lived on the *wasipungo* and performed occasional work for the hacienda
bahareque	a form of construction based on woven horizontal strips of cane grass mixed with mud, and roofs of highland bunch grass
bohios	small rounded constructions used to support hunting activities in highland areas
cabildo	organisation of leaders from a traditional Andean community
campesino	smallholder, peasant farmer
cangahua	hardened soil composed of cemented volcanic ash
carchense	person from the Province of Carchi in Northern Ecuador
casicazco	a feudal-like social structure found in Ecuadorian indigenous cultures to the south
cacique	traditional leader and strongman
chacqui taclla	a foot driven wooden shovel used for turning over soil
chuño	a freeze-dried potato common to the cold and dry regions of the Southern Andes
curaca	the priest or leader of a traditional Andean community prior to the Spanish arrival and during the initial stages of colonisation
El Niño	a climatic event associated with the global phenomena of shifts in ocean currents and ensuing weather changes; in lowland areas of the northern Andes it signifies high rainfall and in highland areas drought
encomienda	a Spanish policy based on the assignation of concessions of land and the native people who lived on it
encomendero	a subject of the *encomienda* system, similar to a slave or indentured servant
gringo	a foreigner, especially a white person from North America or Europe; originally a derogatory Mexican term for a person from the United States
hacendado	the owner of an hacienda; also known as a *patrón*
hacienda	large landholding or plantation originally awarded to ex-conquistadors and Catholic subjects, commonly extending thousands of hectares during Spanish rule. In modern times, a hacienda may be owned by heirs or purchased privately and cover 500 hectares of more.
ingeniero	a Bachelors-level academic degree in a technical field, such as agronomy or engineering; a class of technical professionals
intermediarios	a farming style of land lenders involved in agriculture production
jornalero	a landless labourer
latifundio	a large, rural landholding or plantation
licenciado	academic title of bachelor in the social sciences (excluding Economics), used to address a professional, such as a lawyer or nurse; a designation for showing respect
mayordomo	administrator or administrative assistant of a plantation or hacienda; person in charge of organizing labour and production activities on haciendas
mestizo	person of mixed Native American and Spanish ancestry

mindales	merchants under the pre-Hispanic *casicazco* social system
minifundio	a small, rural landholding supporting a family-level subsistence economy
mitmaq (or mitimae)	forced labour arrangements under Incan rule and later continued by the Spanish
Pastos	(Spanish for "pasture") Spanish name for the combined Capulí, Cuasmal, and Tuxa civilisation during the period of about 1250-1525, which spanned a lush green highland territory along the Ecuadorian-Colombian border. Today, anthropologists commonly refer to the people who occupy this region as the *Pastos.*
páramo	wet montane and alpine environment common to the highlands of the northern Andes
pragmaticos	a farming style of pragmatic, risk-averse agriculture production
puno	arid and semi-arid highlands common of the southern Andes
patrón	owner of the hacienda; also known as the *hacendado*
precarista	informal labourer and producer, such as the *wasipungero*, that exist outside the market economy
quintal	a unit of measurement of 100 pounds, based on half the load of a horse or mule; the weight of a full maize or potato sack
Real Audiencia	under the "New Laws" of 1542, entitlements that were conferred to the local governing unit of royal subjects
repartimiento	a series of laws that attempted to create more flexible labour markets; those who did not benefit from the *encomiendo* but who had labour needs demanded this legislation. The *repartimiento* implied forced labour paid a fixed price upon completion of a contract.
sierra	mountains region or highlands
sistema de consertaje	a legal transformation of the *wasipungo* system in the 1920s
sistema de latifundio-minifundio	a feudal system of production based on large landholders (*latifundistas*) who organized and controlled production of surrounding smallholders (*minifundistas*) who paid rent for access to land, water, forest, and other resources either through labour, commodities, or currency
Sucre	Name of the Ecuadorian currency up to dollarisation of the economy in March 2001; named after José Antonio Sucre, the Venezuelan leader of the nationalist liberation movement from Spain in the northern Andes
Tawantinsuyo	Incan territory and administrative structure that stretched from Northern Ecuador to Chile during much of the 15th and 16th centuries
técnico	a person with technical training; a class of professionals who promote modern agriculture technology
terrateniente	a large landholder
wachu rozado	a pre-Colombian limited tillage system used in potato production
wasipungo	settlement of *wasipungeros* located on a hacienda
wasipungero	indentured servants on the hacienda
yanapero	landless, part-time labourer who works on the hacienda in exchange for non-monetary payment, such as access to firewood or pasture

Chapter 1
Introduction

In 2004, the British Broadcasting Company's (BBC) World Service produced a special series on the social and environmental problems generated through globalization, including a story about modern agriculture in Carchi, Ecuador, entitled *Dying to Make a Living*.[1] The program opened with an explanation that medical researchers working with the International Potato Center (CIP) had discovered serious health problems associated with pesticide use in potato production – among the highest rates of poisoning reported anywhere. The problem was not due to the continued distribution and sale of pesticides or products that had been made illegal in Europe or the United States. Instead, it was the result of the widespread use of properly registered products combined with a reality identified by the pesticide industry itself (Atkin and Leisinger, 2000:126): "pesticides are used unsafely under the socio-economic conditions of developing countries" and "…it appears that there are few if any easy ways to promote change among large numbers of poor smallholders." Provided those unsavoury facts, the industry financed study recommended: "…any pesticide manufacturer that cannot guarantee the safe handling and use of its toxicity class 1a and 1b products should withdraw those products from the market." As a result of the widespread use of these "highly toxic" pesticides and other problematic but less toxic products, the CIP-led studies in Carchi concluded (Yanggen et al., 2003:195), "The health problems caused by pesticides are very severe and affect an important percentage of the population."

During the story, Euan McIlwraith of the BBC interviewed Christian Verschueren, Global Director of Crop Life International – the umbrella group representing the international agrochemical companies – about the pesticide concerns in Carchi.

> McIllwraith: Is there a pesticide problem?
>
> Verschueren: Mostly what we have identified in the South – whether we are talking about Latin America, Africa, or Asia – are problems with practices of using crop protection products.
>
> McIllwraith: Is it the responsibility of the chemical manufacturers to assure the safe use of their products?
>
> Verschueren: It is clearly a shared responsibility to educate the farmers, and we have shared the responsibility for educating and training them. And we have done this sort of training for the better part of the last 12 years now, educating over 12 million farmers in over 80 countries. It is quite considerable, but of course it is but a drop in the bucket if you compare it to the four billion farmers that live in the world.
>
> McIllwraith: In Carchi, the North of Ecuador, we came across farmers and shopkeepers completely unaware of the dangers of the products they were

[1] The two-part BBC series on pesticides in Carchi, entitled *Dying to Make a Living*, is available at: www.bbc.co.uk/worldservice/specials/1646_dying/index.shtml

using. Do you think it is morally acceptable to sell these products if you cannot guarantee that they will be used safely?

Verschueren: It is difficult to assure 100 percent awareness and 100 percent safety. I think we do recognize that, but we also try to lead by examples, by providing training and education in those particular areas. We recognize that we do not live in a perfect world. But, I do not think that that is a reason for saying that we should stop selling those products. Clearly, farmers in those regions realize that it is a challenge to produce food and cultivate crops, and doing that without their products is not going to be possible.

The industry blamed farmers for abusing their products and passed on the responsibility of controlling biocides to governments. This led McIllwraith to ask a rhetorical question: "Then, why don't countries do something about it?" He went on to interview Carlos Navas, the National Director of Pesticide Regulation at the government *Servicio Ecuatoriano de Sanidad Agropecuario* (SESA), charged with registration and licensing of pesticides in Ecuador, with one central question in mind: "Why has Ecuador not been able to ban highly toxic pesticides, the products that were found to be killing its public and making it sick?"

McIllwraith: Does Ecuador need these dangerous chemicals?

Navas: We need scientific and technological support to be able to cancel product registrations. This office does not have the staff or resources to conduct those studies. So we need studies from abroad or someone to pay us to do studies. Only then could we ban a product.

McIllwraith: Why don't they do it?

Navas: As I said, as well as scientific and technological support, we need cost effective substitutes for certain pesticides. When alternatives are available, then we can ban highly toxic pesticides. There is no possibility to do that without alternatives to the products.

McIllwraith: Do the private companies have any influence over you?

Navas: About 97 percent of the companies that produce chemicals are not national companies. Almost all ingredients are imported, and the State does not have control over those. The companies give courses independently to farmers and only tell them about the good side of pesticides, which influences farmers when they make decision on what to purchase and apply. We cannot control private companies.

In its summary, the program explained that modern potato farming in Carchi presented a conundrum. Farmers said they could not produce without pesticides. CIP researchers agreed that as a result of a number of nefarious pests, commercial potato production in Carchi without pesticides was not realistic. At the same time, the medical researchers and economists argued that the negative health consequences associated with pesticide use placed into question the productivity of potato farming. Meanwhile, the industry did not accept responsibility for harm generated by its products, claiming that they were necessary for "feeding a growing population," and the national regulatory agency claimed it did not have the means to control the companies. The program ended with a single, concise question: Could anything be done?

Uncanny timing: a prelude

I did not arrive in Ecuador in May of 1998 to work on pesticide concerns or to write a dissertation, but rather to purchase an old jeep. My partner Myriam Paredes – the reason why I had moved to South America – had been accepted to study her MSc at Wageningen and would depart for The Netherlands a few months later, leaving me to fend for myself in her native Ecuador. After working day and night for over ten years on sundry rural development projects in Central America, Myriam looked forward to graduate study, and I looked forward to taking a break and getting to know her country. We had lived a minimalist lifestyle in Honduras and rarely took vacations, so money would not be a problem for a while. My immediate goal was to purchase a jeep and spend the ensuing two or three months getting it ready for the rugged roads of the Andes. After Myriam left for Europe, the plan was for our dog Cacho, a Honduran *aguacatero* (literally an "avocado eater" or mutt)[2] and I to travel the countryside for a year. I aimed to acclimate myself to the culture by hanging out in villages and camping and hiking in the mountains. My self-financed sabbatical, as I described it, lasted less than a week.

Prior to departing Honduras, I sent out a letter of interest to Hubert Zandstra, the Director General at the International Potato Center (CIP) in Lima, Peru. I was not immediately interested in finding employment, but felt that I should put out a *feeler* for the future. Amused by a mistake with the date of birth in my *curriculum vitae* (instead of 1966, I had put 1996), Zandstra forwarded my message to Charles Crissman, the person in charge of the CIP-Ecuador station, with the note, "This person has impressive experience for a two year old!" This must have captured Charlie's attention, because he sent me an immediate email reply, "Please come visit us at the CIP research station in Quito upon your arrival to Ecuador. We are in search of a participatory trainer in IPM and may be able to use your services." Two days after my arriving to Ecuador, I found myself seated with Greg Forbes, a CIP plant pathologist, and Charlie over coffee amongst the green houses of the CIP-Ecuador research station, located at the *Instituto Nacional de Investigación Agropecuaria* (INIAP) in Santa Catalina, about 20 kilometres south of Quito.

Charlie told me, "You couldn't have come at a better time." He explained that Canada's International Development Research Centre (IDRC) had just approved funding for the three-year Eco*Salud* (in Spanish, *salud* means "health") project, which centred on continued research into the health effects of pesticides but also interventions to help rural families to decrease their exposure to harmful pesticides. Charlie went on to briefly summarize nearly a decade of economic and health research in Carchi, Ecuador's northernmost province. Referring to a copy of his recently published book, *Economic, Environmental, and Health Tradeoffs in Agriculture* (Crissman et al., 1998), he explained the basic concepts behind economic Tradeoffs of Agriculture Analysis (ToA) as a policy formulation tool. He drew on a white board a figure composed of productivity and health

[2] Unless otherwise noted, the author is responsible for all Spanish to English translations in this dissertation.

axes and ran different technology-based scenarios. For example, he explained, through ToA they had identified a "win-win" scenario where pesticide safety education combined with "off-the-shelf" Integrated Pest Management (IPM) technologies could help rural families avoid exposure to highly toxic pesticides without adversely affecting production. The follow-up Eco*Salud* project, he explained, proposed additional production and health data collection. More importantly, he emphasized, it was time to take all of this research and change things on the ground. Greg explained that they wanted to test the Farmer Field Schools (FFS). I found their enthusiasm contagious and volunteered a summary of my experience.

Since 1988, I had worked with different agencies on peer-based, "farmer-to-farmer" movements in Honduras, Guatemala, and Nicaragua.[3] From a technical perspective, my experience centred on helping hillside farmers improve their agriculture through soil conservation and the use of green manures and cover crops as well as Integrated Pest Management. Growing up in rural New Jersey, I had a strong appreciation for the ingenuity of farmers, which shaped my outlook on development. At university and during my Peace Corps service in Honduras I became steeped in knowledge-based approaches to rural development based on the ideas of Paulo Freire (1973 and 1990). I later worked with Keith Andrews and Jeffrey Bentley at Zamorano, the Pan-American School of Agriculture in Honduras, to train networks of Central American farmers on certain hidden biological phenomena, such as nitrogen fixation or the existence of beneficial insects. During that period I conducted Masters research at Cornell University, which involved a collaborative project with Zamorano to help smallholders to "master the mystery" of plant disease through action research on pathogens and disease management (Sherwood, 1995). My colleagues and I had found that improved "ecological literacy" enabled farmers to better understand the relationships between their agriculture and the environment, thereby leading to more purposeful innovation (Bentley, 1989; Bentley and Andrews, 1996; Sherwood, 1997).

I told Charlie and Greg that while I did not have specific experience with FFS, I was quite familiar with the approach through the literature and interactions with colleagues at the FAO, especially Pat Matteson, a pioneer of FFS in Asia and Southeast Asia, who had joined us at Zamorano's Plant Protection Department the previous year. I explained that our courses at Zamorano similarly focused on helping farmers "to read" the biology and ecology of their agriculture through the study of specific insect pests and diseases. FFS applied similar discovery-based approaches, while also tying learning more broadly to the cropping season – from soil preparation through planting, crop protection, and harvest. Additionally, during my time at Cornell, I had spent a summer working with New York

[3] Farmer-to-farmer emerged from the experience of World Neighbors in Central America in the 1970s, as described in the groundbreaking book on people-centred development *Two Ears of Corn* (Bunch, 1982). Rather than rely on professional extensionists for social organization and capacity-building, farmer-to-farmer depended on the initiative of local volunteers who both developed technology on their farms and worked to diffuse innovation among fellow farmers in their community and surrounding villages. Due to its impressive results, farmer-to-farmer subsequently became both a methodology and movement throughout Central America, Mexico, South America and elsewhere, as described by Selener, Chenier, and Zelaya (1997), Pretty (1994 and 2002) and Uphoff, Esman, and Krishna (1998) and Holtz-Gimenez (2006).

potato growers on IPM. I was confident that with technical support from INIAP's potato team and farmers, we could quickly adapt FFS to potato farming in the Andes.

The timing of my arrival to Ecuador was uncanny. Charlie offered me a job on the spot as a "Participatory IPM Training Specialist," a temporary charge tied to the Eco*Salud* project that potentially could become a more permanent CIP position. I agreed to start the following Monday. I left the research station thinking to myself, how was I going to explain to Myriam, not to mention Cacho, my sudden change of plans?

Arrival in Carchi: discovering the challenges of abundance

During my first trip to the Eco*Salud* project site in Carchi, a four-hour drive from Quito, Charlie and I talked about the difficulties of agriculture in Central America, a region where smallholder farmers were relegated to eke out a living on steep rocky hillsides with little to no rainfall. Education levels were low, infrastructure poor, and access to commercial markets and modern technology limited to non-existent. Admittedly, those conditions made proposals of rural development ambitious. Upon arriving in Carchi, the conversations shifted to the on-going research and the totally different context than the one to which I had become accustomed in Central America. Unknowingly, Charlie framed the issues that would come to occupy much of the next ten years of my life.

In contrast to my experience in Central America, the challenge in Carchi, Charlie explained, was how to support rural development when you've got it all: deep, highly organic soils, 12 hours of sunlight per day, rainfall throughout the year, an educated rural population, good infrastructure, and access to national and international markets. Looking out the window over the green landscape, it was immediately clear to me that the challenges of Carchi were not associated with scarcity but rather abundance. Admittedly, after a decade of working with farmers under the difficult conditions of Central America, the prospect of spending the next few years with these relatively resource rich farmers seemed like a nice breather. Not unlike my previously mentioned sabbatical plans, this respite proved short-lived.

Charlie explained that there were serious problems in the agricultural paradise of Carchi – the "model of modern agriculture." The CIP research confirmed that *Carchense* potato farmers out-produced the rest of Ecuador – 21 t/ha or three times the national average, but it also uncovered a number of hidden problems that placed into question the ultimate returns and sustainability of the potato system. Soils were rapidly degrading, and, in response, farmers over applied fertilisers, which increased productivity but created long-term soil nutrient and biological imbalances. Intensive farming did not just produce a lot of potatoes but also pests, which in recent years had grown out of control, leading farmers to apply more and more pesticides. They came to rely on the cheapest products on the market, which also tended to be the oldest and most toxic. Medical research had found that chronic exposure to pesticides could cause dermatitis, neurological disorders and reproductive problems. In fact, pesticides had become the second leading cause of death in the province and the farmers most exposed were poorer decision-makers and less efficient producers. Meanwhile, potato prices were increasingly variable and unpredictable, leading farmers to lose money on nearly half of their potato crops.

I spent my initial time in Carchi – a good six months – talking with farmers, extensionists, commercial agents, and public officials about the CIP research. The typical farmer argued that he had to compete in the market to survive, and potato was the only viable cash crop in the highlands. Labour had become too expensive for manual ploughing of soil, so tractors needed to be employed. Soils had become "tired," so crops no longer responded without chemical fertilizers. The pests were so aggressive that they would wipe out an entire crop without continual pesticide applications. How could a farmer pay for the modern technologies without cash? For farmers, low prices and highly variable markets were to blame for the situation. They asked for cheap credit and new technologies that could improve production. The typical extensionist commonly argued that technologies were responsible for the prosperity of modern agriculture, a fact that was borne out in statistics showing increased production by area. Alternatives to agrochemicals were "romantic" – i.e., they were either not productive or not cost effective. For extensionists it was irresponsible to question the value of technologies. What farmers needed was greater access to technologies and more training on how to use them appropriately. Extensionists requested funds for more courses and research on new technologies such as improved varieties and better pesticides. The typical agrochemical vendor claimed that the crop protection industry bore a responsibility for feeding the growing population. Without agrochemicals, they argued, many more people would go hungry. Yes, improper management of pesticides could cause harm, but farmers themselves were responsible for misusing products. Vendors generally believed that the benefits of technology far outweighed their harmful effects. They argued that government agencies and NGOs should provide more courses on Safe Use of Pesticides (SUP), as well as access to cheap credit, ostensibly so that farmers could purchase more products.

The different actors argued for what I viewed as more of the same: greater market access and more externally based knowledge and technology, i.e., further agricultural modernisation. The problems associated with agriculture were defined as an oversight or lack of technology or market integration, rather than the product of modern agriculture itself. None of the explanations were wrong, but they were only partial representations.

Andean agriculture was age-old, and farmers had grown potato on the hillsides of Carchi for millennia. What had gone wrong in recent times? No one I consulted placed the problems of agricultural in historical context. There was no questioning of the origins of the pests or market exclusion and even less discussion about relationships between problems and the institutions of science, development, government, and industry that championed ideals of modernity. The problems associated with modern agriculture were an accepted part of modern life; they had become integral with the bucolic Andean landscape.

Charged with enabling a response to the crisis, I eventually realised that I had greatly underestimated the difficulties posed by Carchi. It became clear to me that the same logic that had created the problems of modern agriculture was not going to help farmers overcome their predicament.

A PhD project

The thought of writing a dissertation based on the Carchi experience did not occur to me until after the Eco*Salud* project. In March 2001, I met Niels Röling, who would become my supervisor at Wageningen, at the meeting of the CGIAR System-wide Program for IPM that took place in Nairobi, Kenya, where I was invited to present the CIP-led activity in Carchi.

During my presentation, I argued that despite a wealth of research on the harmful effects of pesticides as well as impressive farm-level results of FFS in enabling alternatives, it was far less clear whether meaningful change was possible for more than a fraction of farmers in Carchi. We had effectively established a "best practice" that was congruent with goals for human and ecological health, productivity, and farmers' incomes. Yet we encountered great difficulty in making it standard accepted practice. We had made substantial efforts to disseminate the research results in communities and at all levels of local and national government. Thousands of farmers, government officials, scientists and development practitioners had participated in seminars on the research findings, and they had seen first-hand how FFS graduates had decreased reliance on pesticides, especially the highly toxics, while sustaining or improving agricultural productivity. Nevertheless, greater forces perpetuated present practice. Local pesticide salesmen, though sometimes visibly moved by the accounts of poisonings, continued to argue that they were tied to the bottom line: sales goals. In fact, a friend in the industry informed me that sale of highly toxics in Carchi were at an all-time high. Officials at SESA, the national regulatory agency, continued to operate under political pressure, which all too often caused them to concede their roles as public advocate to influential private interests. Local government officials seemed interested only to the point where the dramatic events in Carchi could attract attention to their political agenda. Private industry was always quick to step in to prevent "drastic measures" that could interfere with their bottom line. Researchers and extensionists worked from within institutional constraints of their own that limited their ability to respond to promising opportunities that often seemed to lie outside of their disciplinary or project boundaries. Meanwhile, preoccupied with feeding their families, all too often farmers felt that they could not afford to preoccupy themselves with seemingly abstract concerns of health and the environment. Having seen the warnings on product labels, farmers tended to blame themselves for not using pesticides safely. Contrary to popular belief of the day, I had reached the conclusion that change was not a function of knowledge, technology, or cost-benefit analysis. As a result, at the meeting in Nairobi, I argued that the CGIAR needed to move beyond its preoccupation with technology and efficiency and give greater attention to the institutional and political factors that greatly shaped farming outcomes.

I doubt that I was successful at convincing my colleagues to change their agenda, but at the very least, following my presentation, Niels came up to thank me for the talk and to invite me to join him for breakfast the following morning. The next day Niels told me that he held great appreciation for on-the-ground experience, and he liked the interactive agriculture, health, and environmental information included in the presentation. He saw what he described as a highly viable "dead body," which in the sense of an Alfred Hitchcock thriller meant a compelling and scientifically relevant story. Niels suggested a number of provocative sources that could help me further explore my experience, and he encouraged me to come to Wageningen during the summer to write a PhD proposal. I did, and in December 2001, submitted my proposal, which started me on this long and arduous journey.

The dissertation

The dissertation is the direct outcome of ten years of research and development practice in Carchi. It is not a "case study" in the sense of a case that tests a hypothesis. This thesis reflects unfolding experience with different phases of hope, discovery, and ambition.

Justification

For a long time, I worked hard to establish the historical causes of the predicament *Carchense* farmers face and to establish alternatives, especially through introducing IPM practices by means of Farmer Field Schools (Table 1.1). This process led to "hard" results that are themselves of scientific interest, if only because the radically different paradigm and approach to agricultural development that are embedded in the FFS are still in need of further scientifically documented analysis (see van den Berg and Jiggins, 2006). The Carchi experience is perhaps special because of the emphasis we gave to human health, in addition to agricultural production. So far, few studies have explicitly looked at this aspect (see Mancini, 2006 for a recent study in India). But what makes the experience reported in this thesis especially relevant is the fact that the best practice we had established, according to criteria for human and ecological health and production that reflect "development" in every way, did not significantly change potato production in Carchi.

My colleagues and I made great efforts to systematically understand the challenges in Carchi from a multidisciplinary perspective, and we intervened to influence farming practices as well as to introduce systemic change at the potato industry level. This work was widely published (see Appendix A for a long list of publications that emerged from the Carchi activity), and it led to substantial recognition from our peers in both the research and development communities in the Andes and beyond. Our best practice was strongly supported by quantitative "facts," and there can be no question that we did not succeed to introduce our best practice because of lack of rigorous data, demonstrated potential, or exposure of the main protagonists to our results. Thus my long-standing experience faced me with an important second-generation issue that seemed worthy of scientific analysis and promising, not only in terms of making an original scientific contribution as requested of PhD dissertations, but also as an analysis of more global relevance, given the anthropogenic predicament that we humans have created for ourselves.

Table 1.1 Reflective practice: professional developments and milestones associated with this dissertation

Period	Developments and milestones
1998	
June	Employment with CIP and arrival in Carchi
November	Initiation of IDRC-supported Eco*Salud* project
1999	
	Collaborations established with IPM/CRSP and FAO Global IPM Facility
September	Completion of regional training of trainers in FFS methodology and first FFS in Carchi
October	Provincial-wide forum on pesticide impacts in Carchi
2000	
January	Initiation of three-year IDB/PROMSA-supported *EcoSuelos* project
June	Pumisacho, M and S. Sherwood (eds.). 2000. *Herramientas de Aprendizaje: Manejo Integrado de la Papa*. INIAP-CIP-IIRR-FAO, Quito, Ecuador
November	Initiation of two-year FAO-supported project to scale-up FFS throughout Ecuador
December	Sherwood, S. G., R. Nelson, G. Thiele and O. Ortiz. 2000. Farmer Field Schools in potato: a new platform for participatory training and research in the Andes. *LEISA*. December. 16(4): 24-25
2001	
January	Initiation of two-year PROMSA/IDB-supported *Wachu Rozado* project
March	System-wide IPM meeting in Nairobi and meeting Niels Röling
Mar.-Apr.	Independent research at Wageningen
March	Paredes, M. 2001. *We are Like the Fingers of the Same Hand: Peasants' Heterogeneity at the Interface with Technology and Project Intervention in Carchi, Ecuador*, MSc thesis. Wageningen University, Wageningen, The Netherlands
May	National forum on pesticide health, productivity, and environmental impacts, Quito
June	Completion of first Carchi-level training of trainers in FFS
September	Día por Día. 2001. *Amarga Cosecha* (Bitter Harvest). A television documentary produced by Rodolfo Asar. (aired in Ecuador in September and October)
October	Independent research at Wageningen
2002	
February	Colleague Veronica Mera-Orcés dies in an airplane crash on the Colombian border
April	Cole, D., S. Sherwood, C. Crissman, V. Barrera, and E. Espinosa. 2002. Pesticides and health in highland Ecuadorian potato production: assessing impacts and developing responses. *IJOEH: Special series on Integrated Pest Management* 8(3): 182-190
May	Sherwood, S., C. Crissman, and D. Cole. 2002. Pesticide exposure is poisoning in Ecuador: a call for action. *Pesticide News*. London, UK, 55:3-6
June	Pumisacho, M. and S. Sherwood (eds.). 2002. *El Cultivo de la Papa en Ecuador*. INIAP-CIP-Abya Yala, Quito, Ecuador
July	Departure from CIP
July-Aug.	Independent research at Wageningen
November	Employment with World Neighbors Andes Area Program
2003	
January	CEPIP-W/CERES grant
February	Formation of Carchi research team for CERES-supported research (through 2004)
February	Independent research at Wageningen
June	Yanggen, D., C. Crissman y P. Espinosa (eds.). 2003. *Los Plaguicidas: Impactos en Producción, Salud y Medio Ambiente en Carchi, Ecuador*. Abya-Yala, Quito, Ecuador
December	*Carchense* farmers shut down Pan-American Highway in protest over farming crisis
2004	
May	BBC (British Broadcasting System). 2004. *Dying to Make a Living*. A two-part World Service series on globalization and pesticides. Aired worldwide in May
June	Borja, R. 2004. *Documenting Farmer Field School in the Ecuadorian Highlands: A Case Study of Carchi*. MSc thesis, Cornell University: Ithaca, NY
Oct.-Dec.	Independent research at Wageningen

2005	
January	Independent research at Wageningen
January	Sherwood, Stephen, Donald C Cole, Charles Crissman and Myriam Paredes. 2005. From pesticides to people: improving ecosystem health in the northern Andes. Chapter 10 in: J. Pretty (ed.). *The Pesticide Detox: Towards a More Sustainable Agriculture*. Earthscan Publications, London, UK. 147-164
September	Pumisacho, M. and S. Sherwood (eds.). 2005. *Guía Metodológica sobre ECAs: Escuelas de Campo de Agricultores*. FAO-CIP-INIAP-WN. Quito, Ecuador.
2006	
March	Schut, M., 2006. *A House Does not Make a Home: Challenging Paradigms through Farmer Field Schools*. MSc thesis, Wageningen University, Wageningen, The Netherlands
Aug.-Sept.	Independent research with Donald Cole at University of Toronto
2007	
March	Independent research at Wageningen
April	Sherwood, S., D. Cole, and C. Crissman. 2007. Cultural encounters: learning from cross-disciplinary science and development practice over ecosystem health. *Development in Practice* 17(2): 179-195
June	Cole, D., S. Sherwood, M. Paredes, L.H. Sanin, C. Crissman, P. Espinosa, F. Muñoz. 2007. Reducing pesticide exposure and associated neurotoxic burden in an Ecuadorian small farm population. *IJOEH* 13: 281-289
July-Sept	WN-supported sabbatical to write up final chapters
September	Sherwood, S., D. Cole, D. Murray. 2007. It's time to eliminate highly hazardous pesticides (in English and Spanish). *LEISA*, September. 23(3): 32-33
October	Ecuadorian National Congress' Health Committee proposes a law for the elimination of highly toxic pesticides (interrupted by Constitutional Assembly)
December	Independent research at Wageningen
	Schut, M. and S. Sherwood. 2007. FFSs in translation: scaling up in name, but not in meaning (in English and Spanish). *LEISA*, December. 24(4): 28-29
2008	
December	Delivery of dissertation to reading committee

It appears that scientifically established best practice and public acknowledgement of proof of the same are unable to foment social change, be it at the level of farmers, extensionists and facilitators, commercial companies, public agencies or politicians, such as ministers of agriculture. In fact, at all levels, major stakeholders seem to be locked into a non-adaptive, lethal, and eventually self-destructive (from e.g., financial, human health, and soil fertility points of view) system of food production. The long experience and the very "success" of the team, of which I was part, in establishing best practice supported by irrefutable evidence allowed us to hit upon this second-generation problem and gave me the opportunity to make an initial attempt to analyse it.

This dissertation has provided me with a unique opportunity to make sense of the whole disconcerting chain of events. It will hopefully allow me to be more effective in my continuing contributions as an actor and "change agent" in the Andes. The research seems particularly relevant in the face of current optimism that, when governments agree on clear and "... comprehensive controls on carbon movements into and out of the atmosphere, policed with good science, the market is capable of delivering the technologies needed for the staggering cuts in emissions we now know to be essential."[4] In fact, the experience with agriculture technology in Carchi suggests that commercial

[4] New Scientist. 2007. December, 22(29): 5

pressure is capable of preventing governments from establishing clear and comprehensive controls.

Research problems

In all, this dissertation looks at the following series of research problems:

1. The description of the landscape and agriculture in Carchi and analysis of the pathology associated with modern-day potato production in terms of human and environmental health with major conclusions about longer-term economic feasibility and ecological sustainability. This led to the identification of "impact points" for the development of scientifically supported and replicable "best practice."
2. The historical analysis of the emergence of this pathology in a high-potential agricultural area such as Carchi.
3. The ex-post examination of interventions to address the pathology through the application of best practice, especially through enhanced cross-disciplinary research-development practice as well as the introduction of Farmer Field Schools. The latter included the training of a cadre of facilitators to implement the FFS approach beyond the initial pilot project by third-party agencies (community-based organisations, municipal governments, and NGOs).
4. The analysis of the failure to date to make an impact at the policy level, with an emphasis on the institutional factors that, at different levels of aggregation, explain a society-level inability to address the pathologies associated with modern agriculture.
5. An integrated analysis on what we can learn from this rather unique (in the sense of running into a second-generation problem after producing a best practice to solve the apparent *prima facie* pathology) experience.

The resultant thesis is a monograph that tries to establish a coherent "story" among seemingly independent stories. Many of the experiences and the scientific studies that were carried out during the course of my ten years in Carchi and that feed into this thesis have already been published elsewhere (Appendix A). Rather than concentrating on a single theoretical framework, due to the multiple levels of inquiry and the inherent complexity of the study, I placed different conceptual "lenses" on the history of Carchi as well as personal experience with local- and national-level interventions to establish empirical data. I then searched relevant literature for more critical theoretical perspectives at both the levels of discrete (i.e., individual chapters) and integrated (the book) inquiry. As a result, the research was guided by an iteration of grounded experience and theory, reflecting my perspective as a development practitioner and historical actor in Carchi.

Theoretical framing

The overall objective of this research is to provide fresh historical and social perspectives on the pathology of modern agriculture in Carchi and the limitations of current research and development efforts to address that situation.

Table 1.2 summarizes the overall research approach that I employed in this dissertation. Following the identification of the earlier mentioned problems, I applied the following investigative lenses:

1. Historical organization of modern agriculture in Carchi for greater social insight on how the present-day situation came to be;
2. Practice of research-development aimed at addressing the problems generated by modern agriculture;
3. Multi-institutional realm of policy and politics;
4. Socio-biological phenomena of agricultural decline in Carchi.

My inquiry was guided by a series of questions linked to the different research lenses as well as theoretical explorations. I found it difficult to see beyond my own paradigms because a paradigm – as one's model of signification and abstraction – defines how one sees. As a result, I aimed to be explicit about my own thinking and its evolution over the duration of this research. During initial data collection and processing and analysis, I continually explored relevant literature for further information, insight, and explanation. Sometimes my explorations simply produced additional information. For example, Lándazuri's (1995) work on the violent depopulation of Carchi during the sixteenth and seventeenth centuries helped me to understand why the region's natural resources largely remained in tact through the beginning of the twentieth century. Other times, a search led me to see things in entirely new ways. For example, Giddens' (1990) work on the phenomenology of modernisation helped me begin to understand agricultural decline in Carchi as not just the result of technical oversights or a lack of technology, but the expected product of modernisation itself. Theory brought both greater resolution to my research lenses as well as entirely new perspectives, thereby providing new colours, shapes and contours to my observations and experience. It provided me entirely new ways of seeing and thinking as well as further explanatory power.

With regard to the first lens (historical perspective), the main research question became:

> *What historical events preceded agricultural decline in Carchi?*

During my research on the historical events leading up to modern-day Carchi, I immersed myself in the Andean historical, anthropological, and sociological literature. Troll (1968) explained the geographic division between the southern *puna* or dry Andes and the northern *páramo* or wet Andes, which helped me to place Carchi's environment in context within the broader Andean landscape. I came across Murra's (1972) theory of "vertical control," explaining agricultural and agrarian differentiation along altitudinal belts, as well as Salomon (1980) and López-Sandoval's (2004) applications of that theory to the

Table 1.2 Research strategy: lenses, theoretical explorations, information sources, and methods

Lens/guiding question	Theoretical explorations	Information sources	Methods
Lens 1: Historical realm • *What historical events preceded agricultural decline in Carchi?*	• Andean socio-cultural development: Murra (1972), Costales and Costales (1974), Uribe (1977), Barsky (1978, 1984, 1988), Barsky and Cosse (1981), Newson (1992), Landázuri (1995), Escobar (1995), Rostworowski (2001), Murra (2002) • Agricultural modernisation: van der Ploeg (2003) • Resilience and adaptive management: Holling (1973, 2000), Gunderson and Holling (2002)	• Published literature • Hacienda records • Transcriptions • Crissman et al. database (1990-1992) • National Census data (1954, 1974, 2004) • Paredes and Sherwood database (2003-2004)	• Critical review of secondary sources • Semi-structured interviews with key informants • Participant observation • Interactive workshops
Lens 2: Project realm • *What social and institutional factors prevented the uptake of recommended best practice, in the form of cross-disciplinary research and knowledge-based, people-centred interventions?*	• Development: Röling (2000), Röling and Leeuwis (2001) • Modernisation: Giddens (1990, 1994), Beck (1992) • Socio-technical change: Nelson and Winter (1977), Rip and Kemp (1998), Gibbons et al. (2000), van der Ploeg (2003)	• Personal experience • Notebooks • Transcriptions • Project documents • Paredes and Sherwood database (2003-2004) • Paredes (2001) • Student theses: Paredes (2001), Mendizabel (2002), Borja (2004), Schut (2006)	• Reflective practice • Participant observation • Semi-structured interviews with key informants • Qualitative analysis
Lens 3: Policy realm • *How did institutional actors respond to policy proposals for the elimination of highly toxic pesticides?*	• Risk society: Haraway (1989), Giddens (1990), Beck (1992), Beck, et al. (1994) • Actor Network Theory: Callon (1986), Latour and Woolgar (1979), Law (2004) • Sociology of development: Jansen (2000, 2008), Long and Long (2002)	• Personal experience • Notebooks • Transcriptions • Project documents • BBC interviews	• Reflective practice • Semi-structured interviews • Qualitative analysis
Lens 4: Integration • *What were the institutional features behind the production and continuity of agricultural decline in Carchi?* • *What lessons does Carchi hold for more sustainable agriculture?*	• Risk society: Beck (1992, 2000, 2001); Beck et al. (1994), Giddens (1990), Adam et al. (2000), Van Loon (2000) • Resilience and adaptive management: Holling (1973, 2000), Gunderson and Holling (2002)	• Lenses 1, 2, and 3	• Summary • Integrated analysis

northern *páramo* Andes. This body of literature shed new light on the ecological implications of the arrival of the Spanish and the subsequent horizontal redistribution of land under the hacienda system, as per the practice in Spanish *mesas*. With this insight, I was better able to explain certain environmental vulnerabilities in *Carchense* agriculture centuries later.

Rostworowski's (2001) anthropological research exposed me to new details of traditional Andean culture, and Uribe (1977) and Landázuri (1995) revealed agricultural practice and social differentiation of the Pasto civilisation that settled at the border region of present-day Ecuador and Colombia. This research enabled me to more fully appreciate the depth of social disruption during the colonial period and the absence of native languages and indigenous populations in modern-day Carchi. Newson's book "The Cost of the Conquest" introduced me to the diverse patterns of the Spanish Conquest in Latin America, and the evolution of its policies to gain control over territory and people. The detailed historical analyses of Costales and Costales (1974) and Barsky (1978, 1988) provided insight on the historical events leading up to agrarian reform in the 1960s as well as its negotiated outcomes and expressions in northern Ecuador. This body of literature explained the unique pattern of land distribution in the north that influenced the prominence of smallholder agriculture in Carchi today.

I referred to Escobar (1995) and McMichael et al. (2000) for a general introduction on how agrarian reform was tied to constructions of poverty and development as well as modernist ideals of market integration and technological development. I drew on Barsky and Cosse (1981) and Barsky (1984, 1988) to understand how foreign development aid and technical assistance arrived in Ecuador and became an integral part of agrarian reform and ensuing agricultural modernisation policies.

I close my historical reflections with an examination of the Carchi experience in light of van der Ploeg's (2003) research on the modernisation of Dutch agriculture. I then draw on the resilience and adaptive management literature, especially Holling (1973, 2000) and Gunderson and Holling (2002), to explore the interactive socio-biological factors influencing the historical macro tendencies in Carchi.

With regard to the second lens (project-level perspective), the main research question became:

> *What social and institutional factors prevented the uptake of recommended "best practice," in the form of cross-disciplinary research (i.e., the Eco*Salud *project) and knowledge-based, people-centred interventions (Farmer Field Schools)?*

During my research on contradictions between development discourse and practice, I read Röling's (2000 and 2005) articles on the "ecosystem challenge." This work provided fresh perspectives on the interactive biological and social dimensions of the "modern predicament" and pointed me to new schools of thought, including the Santiago Theory on the biological roots of knowledge (Maturana, 1996 and Maturana and Varela, 1998), Reflexive Modernisation (Giddens, 1990 and 1994), and Risk Society (Beck, 1992). This material influenced my thinking throughout the remainder of the course of this dissertation.

Ensuing dialogue with Röling introduced me to literature on the management of complex issues associated with social systems and the environment (Miller, 1983 and 1985; Bawden, 2000), as well as the Resilience Alliance (Holling, 1973 and 2000). This heightened my awareness of the need to break down disciplinary and professional barriers in agriculture research and development practice. Leeuwis' (2004) review of rural innovation and subsequent conversations helped me to appreciate both the opportunities and underlying problems of paradigm and process inherent in cross-disciplinary research-development practice.

Ironically, I struggled most during my explorations of an area where I had gained the most experience – the implementation of Farmer Field Schools. It took me over two years to write up that experience and my drafts underwent numerous transformations. Eventually, I settled on the work of Gibbon et al. (2000) to analyze the experience through an application of the Mode 1 (expert-led) and Mode 2 (lay or people-centred) framework of knowledge production. A need to explain institutional struggles over the multiple and divergent expressions of FFS took me to the literature on socio-technical change (Nelson and Winter, 1977; Rip and Kemp, 1998; Geels, 2004), technology management (Rosenkopf and Tusman, 1994; van de Ven and Garud, 1994), and evolutionary economics (Potts, 2000; Schot and Geels, 2007). I also consulted van der Ploeg's (2003) *The Virtual Farmer*, which provided much insight into the organisation of expert systems and their influence over farmers, farming, and rural life.

With regard to the third lens (policy-level perspective), the main research question became:

> *How did institutional actors respond to policy proposals for the elimination of highly toxic pesticides?*

Nuijten's (2002) research on corruption in Mexico and Jansen's (2000 and 2008) work on the struggles over pesticide policy agenda in Honduras helped me break through my rather conventional understandings of government, governance, and regulation. Following further exploration of Latour (1987) and Knorr-Cetina's (1999) work on the "constructedness" of science, I adopted the view of pesticides as a ready-made product of science around which networks of actors had consolidated and matured. This led me to explore "modes of enactment" – the creative ways in which individuals and networks of actors produced myths around the "indispensability" of technologies (i.e., agrochemicals) and the translation of prestigious symbols (e.g., FFS and IPM) as means of consolidating belief systems through which interests were promoted, rules were created and enforced, and discretion was exercised.

I drew on aspects of Actor Network Theory (ANT) (Callon, 1986; Latour and Woolgar, 1979; Law, 1992 and 2004) to further explore observed processes of "heterogeneous engineering" during which social, technical, and conceptual pieces become fitted together into co-evolving structures of influence. I applied this insight to explore how people do not just network to interact with other people but also to interact with people and materials, in this case over agriculture technology. ANT helped me to explain an observation that networks of objects – agrochemicals – participated in the social, thereby influencing human relationships and activity. If pesticides disappeared, as I came to argue, then so would a particular social order.

I employed aspects of the Risk Society (Beck, 1992 and Beck et al., 1994) and Reflexive Modernisation (Giddens, 1994) theories to investigate how a pro-pesticide alliance in Ecuador ultimately consolidated influence and authority in its attempt to perpetuate the continued sale and distribution of harmful technology. The insights from this body of work helped me to understand the rise of dissent over pesticides in the form of a breakdown of allegiances and the emergence of sub-political movements and how ultimately the institutional claims to knowledge and technology and the deepening and broadening of pesticide effects on society and the environment may be providing the pre-conditions for demise and change.

With regard to the fourth lens (integrated perspective), the main research questions became:

> *What were the institutional features behind the production and continuity of agricultural decline in Carchi? What lessons does Carchi hold for more sustainable agriculture?*

For integrated analysis of the earlier research, I returned to the Risk Society (Beck 1994, 2000, 2001; Adam et al., 2000; and van Loon, 2000) and Reflexive Modernisation (Giddens, 1994) literature to summarise the general features of the pathology of agricultural decline in Carchi and to establish ties to broader processes of globalisation. This enabled me to assess the degree to which Carchi had become a theatre of risk.

Additionally, I drew on the Resilience literature (Holling, 1973, 2000; Gunderson and Holling, 2002) to explain the interactive socio-biological phenomena associated with the development and use of agriculture technology in Carchi and subsequent environmental feedback, primarily in the forms of soil fertility loss and the proliferation of pests. I found the applications of the metaphor of the "lazy eight" in Hurst (1995), Röling (2002, 2005), and Jiggins et al. (2007) useful for describing the seeming oxymoron of sustainable development and identifying opportunities to guide needed institutional change.

<u>Research approach</u>

Table 1.2 summarises the research strategies employed in this dissertation. Each chapter independently provides details on relevant methodological considerations. As per the challenges posed by each particular research lens and its corresponding questions, I drew on diverse information sources, research methods, and theoretical explanations. I employed both quantitative and qualitative techniques. Due to the wealth of existing quantitative information from the earlier research in Carchi (Appendix A), including the on-going research of Paredes (in process), I limited quantitative methods to standard

descriptive statistics, for example, of historical production data, and relied most heavily on qualitative strategies.

Information sources

To ground the research in locality, I focused on four case study sites. Three of the four locations (Santa Martha de Cuba, San Francisco de Libertad, and San Pedro de Piartal) were chosen *a priori* by the CIP research team in 1998. Sites were chosen based on geographic location (to include both the western and eastern Andean ridges), relevance of potato production, and self-selection (i.e., communities agreed to take part in the medical studies). In 2004, Paredes and I added a fourth site to our respective research, Mariscal Sucre, due to expressed interest of the community to address pesticide health issues and an on-going IDRC-funded sister project on "sustainable biodiversity" with the NGO EcoPar, which committed additional human resources to data collection.

To avoid selection biases, the research included the perspective of broad categories of actors from communities and among public officials, scientists, and development professionals working in the province. For community participant selection, I heavily drew on Paredes' (2001 and in process) quantitative and social analyses of "farming styles" in the same case study sites as a means of assuring heterogeneity in my populations.

I had access to diverse quantitative information sources, including existing CIP databases from the 1990-1992 field research as well as the Eco*Salud* activity between 1998-2001. Additionally, Paredes and I constructed a complementary database of production information from 94 potato fields of 92 farmers across the four case study sites during the 2003-2004 growing season. For historical information, I relied on National Census data from 1954, 1974, and 2004 as well as processing of that data by other authors, especially: Costales and Costales (1971), Barsky (1984 and 1988), Cosse (1980), and most recently An (2004).

My role within the CIP research team permitted unique access to project events, informal communications, grey literature, and official documents. Over my professional career, I have developed the habit of taking copious notes during daily conversations and project activities. For qualitative data, I utilised my field notes from the Eco*Salud* project between 1998-2002 as well as those from subsequent work with the FAO between 2001-2003. I had access to essentially all of CIP and INIAP's project documents from Carchi between 1990 and 2003. Further, I analyzed transcriptions from semi-structured interviews of key informants, including community members, researchers, public officials, and representatives from private industry. These included interviews that I held directly as well as those conducted by my project staff. Additionally, I obtained the original recordings of interviews held by the *Día-a-Día* program during its production of the documentary *Amarga Cosecha* (Bitter Harvest) and BBC's World Service program *Dying to Make a Living.*

Interpretation and analysis

As a historical actor in Carchi, analyses largely resulted from reflective practice and direct observation of agriculture, research, and development in practice. While my role as an "insider" provided substantial access to the inner workings of projects, my mixed role as intervener-researcher posed considerable methodological challenges, especially over measurement bias. This included both my ability to dispassionately listen to informants and interpret experience as well as preventing informants from limiting their responses to socially desirable answers. Over the years, I expressed my positions in publications, public events, and the media. As a result, farmers, public officials, and industry representatives tended to tell me what they thought I wanted to hear, which may have been an endearing cultural trait but one that could greatly bias research outcomes. Paredes (in process) faced similar challenges.

Consequently, between 2003-2004 Paredes and I employed an independent, multidisciplinary team of four national researchers made up of an agronomist, forester, economist, and sociologist to assist in our respective data collection. We added additional people when research demands were high, for example during planting periods. We trained the team in quantitative and qualitative research techniques, as per the needs of particular inquiries. Throughout that period we held regular bi-weekly discussion sessions and planning meetings. The research team collected secondary data, it conducted interviews with farmers, agrochemical salesmen, industry representatives, public officials, and technical specialists, made homes visits, and held meetings with focus groups to discuss and review findings. Team members generated raw data (e.g., notes, interview recordings, and surveys) and produced technical reports on topics of particular interest (e.g., the arrival of the tractor and agrochemicals or the loss of local potato varieties). This material was presented to other team members and discussed as a means of cross-checking findings. Additionally, I supported specialised research on substantive topics, such as over the nuances of the Farmer Field Schools (Paredes, 2001; Borja, 2004; Schut, 2006), the internal struggles over participatory research at CIP (Mendizabel, 2002), and government policy (An, 2004).

Outline

The dissertation unfolds across eight chapters (Figure 1.1). Chapter 2 provides the contextual backdrop of the research. It begins with a description of the *Carchense* geography and landscape before explaining the local pasture-potato production system. I then summarize the first generation of CIP-led research on the productivity, health, and environmental tradeoffs of potato farming. This research identified a number of concerns, most notably over soil degradation and a latent, endemic health burden associated with pesticides, placing into question the sustainability of modern agriculture. The research included integrated tradeoffs analysis that identified a number of promising win-win educational and technological scenarios, with the implication that the application of best practice would generate corrective action and change.

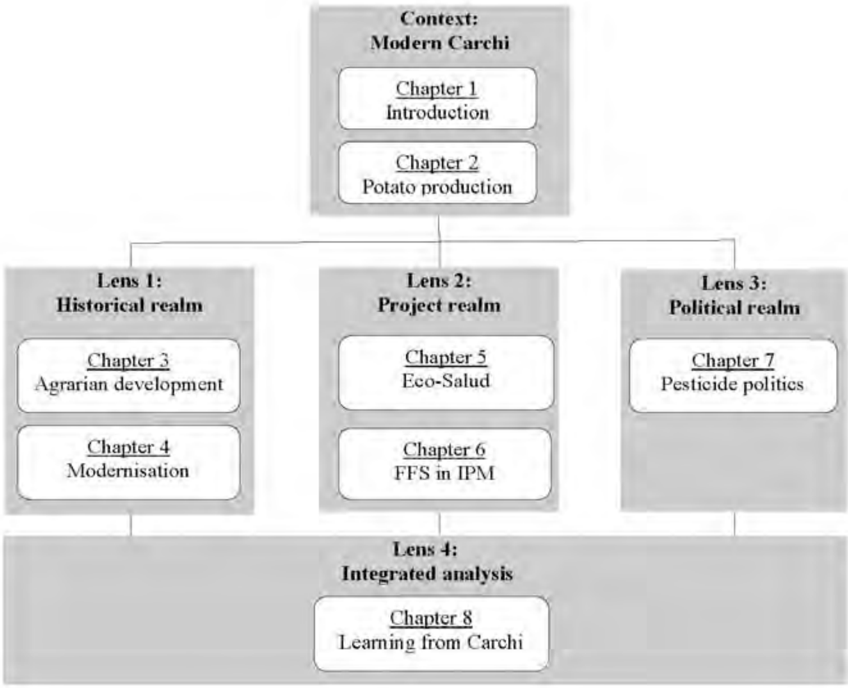

Figure 1.1 Dissertation outline

Chapter 3 initiates my conceptual shift to reflective practice. In order to better understand the current challenges in Carchi, I found it necessary to first look back at the foundations of its modern agriculture (Lens 1: historical realm). The chapter summarises major historical developments since the arrival of the Incas and Spanish up through the hacienda period, and agrarian reform. It looks at how traditional Andean agriculture became uprooted in terms of land distribution, social organisation, and farming practice and how these events shaped modern developments. Chapter 4 concentrates on the period since land reform and recounts the story of agricultural modernisation in four communities. It examines major events of continuity and change in potato production involved in the historic organisation of the "production of decline" – i.e., the establishment of self-destructive tendencies in *Carchense* agriculture.

Drawing on the successes and disappointments of personal experience with the CIP-led initiatives to install best practice in Carchi, the dissertation then shifts attention to the institutional obstacles to enabling change. Lens 2 was placed on project-level interventions, particularly the application of trans- and cross-disciplinary approaches to research-development (Chapter 5) as well as the people-centred, discovery-based Farmer Field Schools (Chapter 6).

In recent time, scientists, development agents, and the public increasingly have become aware of the multi-dimensional nature of ecosystem decline, and hence the need to increase co-operation across scientific disciplines and professional and practitioner cultures (for example, Forget and Lebel, 2001). In Chapter 5, an occupational and environmental health specialist (Donald Cole from the University of Toronto), an agricultural economist (Charles Crissman from CIP), and myself as a rural development specialist recount our knowledge struggles over the three-year Eco*Salud* project – a joint knowledge generation and development intervention for greater "ecosystem health" in Carchi. The chapter examines the challenges encountered and the compromises made, as it highlights remaining issues for the design and practice of cross-disciplinary research and development.

Farmer Field School methodology – a higher order interactive learning approach that employs well-established principles of adult education, in-depth knowledge of agroecology, and social organisation – has won recognition as state of the art for enabling the transformation of agricultural practice, especially with regard to pesticide use reduction (van den Berg and Jiggins, 2007). Based on my efforts to introduce FFS in Carchi as a means of enabling farmers to address pesticide health concerns, Chapter 6 examines the performance of FFS as well as its spontaneous transformations following its release into the hands of researchers, development practitioners, farmer leaders, and their organisations. The chapter closes with a wider discussion on how FFS, and in general "people-centred" approaches, may evolve from a niche-level contribution to influence the broader trajectory of agricultural development.

The third lens focused on policy-level interventions, as per my personal experience with multi-stakeholder policy formulation involving farmers, conservationists, public officials, scientists, and industry representatives. The diverse donor agencies that supported the research in Carchi, including the Rockefeller Foundation, IDRC, and USAID, demanded that the CIP-led research be based in communities and linked to public policy. As a result, the different projects explicitly sought "community participation," "gender equity," "collaboration," and "multi-stakeholder" involvement in deliberative processes of education and advocacy for change. Based on ensuing public debate over pesticides, Chapter 7 investigates how institutional dynamics came to form, transform, and influence policy outcomes and how certain actors sought to cooperate, collude, and collide to shape public opinion. It goes on to more closely examine how differently positioned actors built and rebuilt allegiances, gained control over public and private resources, and exercised discretion. Ultimately, the chapter exposes institutional dynamics of continuity and change with regard to agriculture technology and how modern societies generate "organised irresponsibility."

The fourth lens was placed on integrative analysis. Chapter 8 draws from the insights of the earlier chapters to precipitate learning from over a decade of activity in Carchi. It opens by directly addressing the questions that guided this research before moving on to describe the generalizable features of agriculture decline. The chapter ends with a discussion on broader lessons from Carchi, potentially useful for informing future research and development practice for more sustainable agriculture.

Chapter 2
Modern Potato Production in Carchi

Summary

This chapter provides the contextual backdrop of this dissertation. It introduces the geography and landscape of the Province of Carchi in Northern Ecuador as well as the modern potato-pasture production system. I then summarize the CIP-led multidisciplinary research on the environmental, health, and productivity effects of modern agriculture. The findings make clear that behind the bucolic setting of the Northern Andes, something has gone wrong: at the turn of the twentieth century, Carchi suffers from a pathology that places into question the sustainability of its agriculture. Lastly, I introduce the results of the integrated tradeoffs analysis that proposed a "win-win" scenario and the identification of scientifically supported and replicable impact points or "best practice" for addressing the challenges in Carchi.

Geography, climate, and landscape

The dense oceanic Nazca Plate is subducted under the lighter continental South American Plate, producing two parallel ridges of the Andes mountain range that run north-south the length of the continent. Located where the equator meets the Pacific Coast, the Republic of Ecuador encompasses an area of 256,370 km^2 and roughly is the size of the United Kingdom (Figure 2.1a). The Andean ridges come closest together at Ecuador, spanning between 40 and 60 km. This geography divides the country into three distinct regions: the *Occidente* (Pacific coastal lowlands), *Sierra* (inter-Andean highlands), and *Oriente* (Amazon lowlands). The unique positioning and dramatic geography of Ecuador make it a country of mega biodiversity. Carchi is Ecuador's northernmost province, located on the border with Colombia (Figure 2.1b).

Situated near the equator, the region receives intensive sunlight throughout the year (Pourrut, 1983). Local convection rather than major weather fronts determines the weather of the inter-Andean valley. Rainfall tends to increase at higher altitudes and at greater distance from the valley floor (Knapp, 1991), while temperature is negatively correlated with altitude. Between the 1930s and the mid-1990s, the National Meteorological and Hydrological Institute (INAMHI) collected data from weather stations throughout Carchi, with the longest term data collection in Tulcán, San Gabriel, and El Angel (Table 2.1). Local hydrological cycles follow a clear bimodal distribution (Figure 2.2). Two periods of peak rainfall are defined for the periods of March-April and October-November. Nevertheless, even during the driest periods, no dry months appear, and crops can be planted without irrigation throughout the year. Located at high altitudes on the equator, temperature variations are not seasonal, but rather diurnal. Means between 11 and 12°C occur between 2,500 and 3,000 meters above sea level (masl), while between 3,000 and 3,400 masl temperature drops to means between ten and 11° C and at 3,400 masl 8 and 9° C (Table 2.1). The geographic position and climatic conditions of Carchi permit continual plant growth, making the province potentially one of the most productive agriculture regions on the planet.

Fig. 2.1a South America

Fig. 2.1b Province of Carchi, Ecuador

Figure 2.1 Location of Carchi

Table 2.1 Meteorological data from four weather stations in Carchi (Crissman, Antle, and Capalbo, 1998)*

	Rainfall (mm)		**Temperature**	
Weather station/altitude	Mean	Std. Dev.	Mean	Std. dev.
San Gabriel (2,860)	950	848	12	10
El Angel (3,065)	984	605	12	14
El Voladero (3,380)	1,314	n.a.	9	n.a.
Tulcán (2,950)	996	850	12	11

* Data for San Gabriel, El Angel and Tulcán averaged over 1970-2000. El Voladero data based on 1985-1995

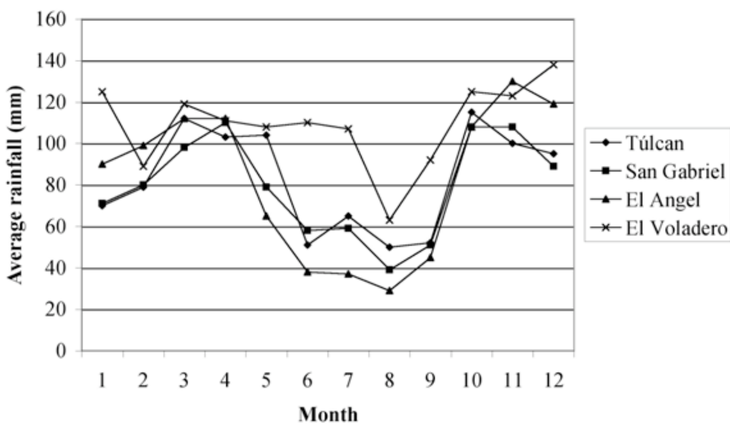

Figure 2.2 Rainfall distribution of Carchi (INAMHI, 1970-2000)

Termed the "*Páramo*-Andes" by Troll (1968), rainfall throughout the year distinguishes the highland region of northern Ecuador, Colombia, and Venezuela from the drier "*Puna*-Andes" of southern and central Peru and Bolivia. Cool temperatures and wet conditions over millennia contributed to the formation of highly organic soils (12-20% by weight) and unique alpine environments, including cloud forest and "*páramo*" or tropical alpine grasslands. Carchi has well-defined western and eastern cordilleras that are topped by an extensive alpine plain with unique *frailejón* grasslands (Figure 2.3a). The western ridge forms one of the country's largest natural páramo environments – the El Angel Ecological Reserve, covering about 14,000 hectares (ha). On the eastern ridge, the inter-Andean slope boasts an extensive 40,000 ha stretch of forest that is perhaps the best surviving example of pristine inter-Andean vegetation (Palacios & Tipaz, 1996). The forest lies on steep slopes and is circumscribed above by alpine *páramo* and below by cultivated agriculture (Figure 2.3b).

Fig. 2.3a. The frailejón *páramo* landscape of the El Angel Reserve, Espejo

Fig. 2.3b. The inter-Andean valley of San Gabriel, Montúfar

Figure 2.3 The landscape

The highland Andes of Carchi rest between 2,500 and 4,000 masl (Figure 2.4). In the early 1800s, the German explorer and scientist Alexander von Humbolt famously characterised the biotic systems of the Ecuadorian highlands by three ecological floors: inter-Andes (2,500-3,200 masl), sub-Andes (3,200-3,600 masl), and Andes (3,600 masl). Two dominant regimes of plant populations dominate the natural ecologies: very humid highland montane forest (in valleys climbing up to 3,400 masl) and the frailejón (*Espeletia pycnophylla* spp. *angelensis*) páramo (3,400 up to 4,000 masl) (Sierra, 1999). The native vegetative cover of the highland forest consists of diverse tree and scrub species, including aliso (*Alnus acuminata*), arrayán (*Mycianthes rhopaloides*), chilca (*Baccharis* spp.), cedro (*Cedrela montana*), pumamaqui (*Oreopanax* sp.), quishuar (*Buddleja bullata*), and yagual (*Polylepus sericea*) (Cuamacás and Tipaz, 1995). The frailejón páramo chiefly consists of *Espeletia* sp. and bunch grasses (*Calamagrositis* sp., *Agrostis* sp., *Stip ichu*, *Festuca* sp.) (Figure 2.3a). Further, the páramo contains rosettes, cushion plants, and dispersed forests of yagual.

The soils of Carchi are exceedingly arable. They were formed by pyroclastic material from the Chiles volcano located on the Colombian border, followed by processes of glaciation. The last eruption of Chiles occurred about ten thousand years ago. The relatively young soils are classified as Andepts and are derived from volcanic ash and pumice (Figure 2.5). Soil formation above 3,000 masl has resulted in surface horizons of one to three meters of dark topsoil composed of high quantities of organic matter (10-25% by volume). Known as black Andean soils (*suelos negros andinos*), these soils have low bulk density, high water holding capacity, and are particularly apt for agriculture. At the same time, an alophane clay structure chemically fixes phosphorus, leading potato farmers to apply high quantities of phosphate fertilizers. Commonly formed on top of a thick layer of cemented ash (in Kichwa known as *cangahua*) that may run ten to 100 meters deep, the soils are highly vulnerable to human activity (Zembrowski, 1997). Absent of topsoil, the subsurface *cangahua* is impenetrable to water and inapt for agriculture (Figure 2.6).

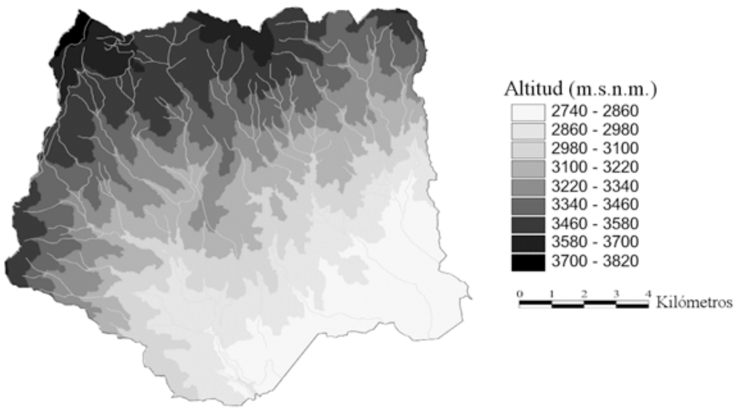

Figure 2.4 Topography of Carchi (Stoorvogel et al., 2003)

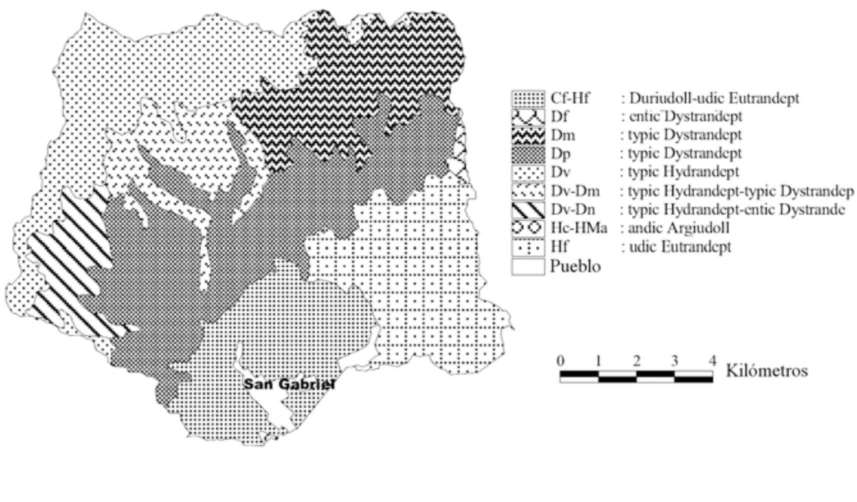

Figure 2.5 Soil variation of Carchi (MAG-Orstom, 1980 in Stoorvogel et al., 2003)

Fig. 2.6a Road cut revealing "black Andean" top soil and sub-soil layer of cemented ash or *cangahua* (San Gabriel, Carchi; Veen, 1999)

Fig. 2.6b Degraded soil of northern Ecuador revealing non-arable *cangahua* (Bolívar, Carchi)

Figure 2.6 Volcanic soils common to northern Ecuador

Farmers cultivate a diversity of crops in the inter-Andean region of the *Páramo* Andes, including maize, alfalfa, and field bean, as well as pasture for animals, chiefly cattle and sheep. In modern time, a potato-pasture rotation on irregular hillsides of up to 45 percent slope and altitudes between 2,400 to 3,800 masl dominates production patterns (Figure 2.3b). Although potato can be found on the flatlands of the central valley, agrarian reform commonly placed farmers on surrounding environmentally fragile hillsides, with expected consequential effects on soil and water resources. Modern population growth in the valleys has aggravated this tendency.

Modern potato production

The highland Andes contains the greatest genetic diversity among cultivated and wild potatoes (*Solanum tuberosum* L.) (Hawkes, 1978; Salaman, 1985; Harris, 1992). Scientists generally agree that the Lake Titicaca region along the border of Peru and Bolivia was the site of potato domestication nearly 8,000 years ago. Archaeological studies have found that diverse ancient Andean groups, including the Tiwanaco, Nazca, Mochica, and Inca, cultivated the crop. In his chronicle of 1538, the Spaniard, Pedro Cieza de León, reported that he found tubers called "papas" in the Cuzco Valle, Peru and later in Quito, Ecuador. When the Spanish arrived in the early 1500s, potato was cultivated throughout the 4,000 km long range of the Andes, in what are now the territories of Colombia, Ecuador, Peru, Bolivia, and Chile.

Of the approximately 2,000 known species of the *Solanum* genus, about 180 plants form tubers (Hawkes, 1978). Of these, only eight are cultivated as edible crops. There are about 5,000 cultivars of potato in the world, of which today Andean farmers commonly grow about 500. In 1994, INIAP conducted a survey of cultivated potato in Ecuador and reported over 400 different types between the species *andigena* and *phureja* (Pumisacho and Sherwood, 2002). Nevertheless, 30 cultivars dominate the modern Ecuadorian landscape, of which the varieties Gabriela and Superchola occupy over half the land cultivated in the crop.

In the sixteenth century, the Spanish introduced the potato to Europe, where it was only cultivated as a curiosity for several centuries in small plots or for botanical purposes (Laufer, 1938). From Spain, the potato spread throughout the continent and the United Kingdom. Andean potatoes only grew well in a few locations in Europe where winters were mild, such as southern Ireland. Early in the seventeenth century, the crop was introduced to North America, most likely from England. Over time, as the potato adapted to the climate and farmers selected more precocious varieties, potato cultivation became economically viable in the northern temperate climate. In Europe, potato generally was first used for animal feed and was not commonly considered for human consumption. Only in the eighteenth century did Europeans and North Americans begin to consider the potato a source of low-cost human food, particularly during periods of scarcity due to failures of cereal crops and wars. Over time, however, the crop became a basic food source the world over.

Today, the worldwide circulation of root and tuber crops generates about $41 billion each year, representing one-fourth of the combined value of the cereals wheat, rice and maize (Scott et al., 2000). Of the root and tuber crops, the potato has the highest economic value (about $16.5 billion/year). It ranks fifth in weight of production among the world's food crops. In terms of nutrition, the potato contributes about one-fifth as many calories as rice, wheat, and maize to the world diet. The countries with the most area under potato cultivation are: China (3.5 million ha), the Russian Federation (3.4 million ha), Ukraine (1.6 million ha), Poland (1.4 million ha), and India (1.1 million ha). In Latin America, despite being the crop's centre of origin, only about 1.1 million hectares are dedicated to the crop each year, of which Ecuador grows about 43,000 ha,[1] which is down from about 66,000 ha during the 1990s (Herrera, 1999; INEC, 2002). The countries with the greatest potato productivity are: The Netherlands (44 t/ha), US (39 t/ha), Belgium and Luxemburg (38 t/ha) and Canada (27 t/ha) (CIP, 1998; Scott et al., 2000). Of the Latin American countries, Argentina has the greatest productivity (22 t/ha), followed by Chile and Brazil (15 t/ha). In the Andes, farmers in Colombia and Venezuela grow about 16 t/ha of potato. The lowest productivity can be found in Bolivia and Ecuador, which respectively produce on average six and nine t/ha.

In the developing counties, total potato production has more than doubled since 1965, with most growth occurring in Asia and Africa (Scott et al., 2000). Through 2020, yearly potato production in developing countries is projected to grow at about 2.7 percent, which is greater than that expected for maize, wheat, or rice. The greatest growth likely will occur in Asia, followed by Africa and Latin America. In the last 30 years, Latin America has experienced an increase in potato productivity instead of an increase in area dedicated to the crop. The growth in overall regional production for this period was about two percent. Presently, the number of potato growers in Ecuador is about 42,000 predominantly smallholder farmers (INEC, 2002). The country produces about 480,000 tons of potato with a brute value of $60 million, maintaining the potato as an important source of food and income, especially for rural communities. Carchi is Ecuador's most productive province, producing about 40 percent of the country's potato harvest on only 25 percent of the land dedicated the crop.

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[1] Based on SICA-MAG data for 2006, available at: www.sica.gov.ec (accessed 1 October 2008).

Consumption

> *Cuando en la sopa no hay papas, es como si fuera agua, aunque tenga fréjol, arveja, col...* (When in the soup there is no potato, it's as if it were water, even if there are beans, peas, and cabbage…) – a popular saying in Carchi

Andean cultures discovered roots and tubers as a valuable source of energy (Woolfe, 1987). The nutritive quality and quantity of the potato varies by cultivar and cropping conditions. Water content may range from 63 and 87 percent, carbohydrates 13 and 30 percent (including fibre content 0.17 and 3.48%), proteins 0.7 and 4.6 percent, fats 0.02 and 0.96 percent, and ash 0.44 and 1.9 percent. Other basic nutrients include sugars, ascorbic acid and minor vitamins.

While cereals and pulses are part of a large international trade market, only a small percentage of potato harvests is exported from countries. The high water content, bulkiness, and perishability of tubers complicate their transport. In the dry *puna* Andes to the South, pre-Incan cultures learned to freeze-dry potato as *chuño* that was transportable and capable of storage – qualities essential for surviving crops failures and war. Nevertheless, *chuño* could not be produced in the wet *páramo* environments of the northern Andes, greatly limiting the utility of the crop. As a result, pre-Colombian cultures of the northern Andes preferred maize (Landázuri, 1995). In that region, potato and other Andean roots and tubers were relegated to highland areas, where little else survived the severe conditions.

For the people of modern-day Ecuador, potato has become a principal food source, with an annual per capita consumption of about 100 kg (Herrera et al., 1999). Ninety percent of potatoes in the northern Andes, where crops can be grown year round, are consumed immediately as fresh tubers. As a result, varieties are not adapted for storage, in contrast to the more temperate climates of Peru and Bolivia as well as Europe and North America. The food processing industry in Ecuador consumes about 50,000 t/yr or ten percent of the annual production. Since 1994, the consumption of fast food in Ecuador has increased sharply at an annual rate of about six percent. Restaurants in Quito and Guayaquil only consume about 16,000 t/yr, principally as French fries, but that number is growing.

Potato-pasture system

Upon arrival in 1997, my information on potato production in Carchi was based on two primary sources of data. Between 1990 and 1992, Crissman et al. (1998) studied 320 plots of 40 farmers in the San Gabriel area. This research contributed to a large number of economic and health publications, including: Antle, et al. (1994), Antle et al. (1998), Crissman, et al. (1994), Cole, et al. (1997a), Cole et al. (1997b), and Cole et al. (1998). Secondly, in 1998, Barrera, Norton, and Ortiz (1999) conducted a survey of 100 farmers between Tulcán, Huaca, Montúfar, and Espejo. This information concurs with findings based on the earlier datasets, except for increases in input prices and lower production per area, which apparently was due to an unusually dry year. Later, Yanggen et al. (2003) drew on these same two data sources for their description of the production system. I similarly rely on these sources. For biophysical aspects of potato production, I draw heavily on the local studies summarised in Pumisacho and Sherwood (2002).

Carchi has been described as a model of the spread of industrialized agricultural technologies in the Americas during the Green Revolution that began in the 1960s (Barsky, 1984). A combination of traditional sharecropping, land reform, market access and high value crops provided the basis for rural economic development. Furthermore, as a result of new revenues from the oil boom of the 1970s, the Ecuadorian government improved the transportation and communication infrastructure in Carchi. An emerging agricultural products industry was quick to capitalize on the availability of new markets. Today, a typical small farm in Carchi is owned by an individual family and consists of several separate, scattered plots with an average area of about six hectares.

During the second half of the twentieth century, farming in Carchi evolved towards a market-oriented potato-pasture system based on a three to five year rotational system. One or two cycles of potato are followed by a combination of secondary crops, including wheat, maize, bean, favabean, barley, peas, oca or melloco, to take advantage of residual fertilizer from potato. Farmers follow this rotation with one or two years of "rest" in spontaneously occurring grassland for diary and meat cattle. Due to the intensiveness of the system, it depends on external inputs to maintain fertility and control pests. Between 1954 and 1974 potato production increased by about 40 percent and worker productivity by 33 percent (Barsky, 1984). Until recently, the potato growing area in the province continued to swell, with yields rising from12 t/ha in 1974 to 21 t/ha in 1992, a remarkable three times the national average (Crissman et al., 1998b).

Production costs

During the early 1990s, farmers in Carchi invested on average about $1,500 per ha in potato production (Table 2.2) (Crissman et al., 1998b). About 25 percent of outlays went towards labour (valuing both family and paid labour as worker days). The average six-month potato crop employed about 157 workdays/ha, with about 85 percent for men and the remainder for women. Labour came both from family and hired sources. Women were most involved in planting and harvest (Table 2.3). Rarely were they involved in crop management or the applying of agrochemicals. During the 1990s, farmers in Carchi cultivated about 15,000 ha/yr of potato, signifying about 2,355,000 workdays of employment for the province. About 32 percent of total investment was in fertilizers and pesticides. The remainder of variable costs went towards land preparation, harvest, and transport (12%). Twenty percent of outlays went towards fixed costs, such as land rent and interest on loans.

Profitability of potato production was generally positive but highly variable. In Carchi, most potato was sold weekly in local markets of San Gabriel and Ibarra, depending on location of fields. Potato farmers found highly variable prices across varieties at harvest time. Price at harvest was important, since potatoes in Carchi are not bred for storage, nor are the conditions in the wet páramo Andes favourable for storage. Since Carchi is located near the equator and rainfall is evenly distributed, monthly price fluctuations were not determined by season, but rather comparative prices with neighbouring Colombia and Peru as well as dumping of commodities by countries in North American and Europe. As a result of such factors, Crissman et al. (1998a) found that between 1990-1992 farmers lost money on about 43 percent of their potato crops. To confront high price variability in potato, farmers applied the strategy of "playing the lottery," which involved continual production while gambling for high prices at harvest to recover overall investment. In summary, potato production in Carchi was a highly risky enterprise.

Table 2.2 Average production costs for one hectare of potato (USD) (1990-1992) (Crissman et al., 1998b)*

Category	Sample (n)	Quantity	Cost (US$)	Percentage of total cost
Variable costs				
Labour				
Family	320		288	18.7
Contract	103		55	3.6
Harvest	270		45	2.9
Total labour		157 days	388	25.3
Seed	320	1,716 kg	148	9.7
Fertilizers			302	19.6
Nitrogen, a.i.	320	138 kg		
Phosphorus, a.i.	320	327 kg		
Potassium, a.i.	317	163 kg		
Foliar	207		11	0.8
Total fertilizers			313	20.4
Pesticides				
Fungicides	320		128	8.3
Foliar insecticides	314		26	1.7
Soil insecticides	268		34	2.2
Total pesticides			188	12.2
Animal and mechanical traction	153		17	1.2
Back-pack sprayers	320		10	0.7
Harvest	320		53	3.5
Transport	319		105	6.9
Total materials/services			185	12.2
Total variable costs			1,222	79.8
Fixed costs				
Interest			232	15.2
Rent			77	5.0
Total fixed costs			309	20.1
Total costs			1,531	100

* Note: Average harvest = 21.3 t/ha; gross income = $1,941; net income = $410/ha. Exchange rate increased from 890 Sucres/USD in 1991 to 1,700 Sucres/USD in 1992. The authors used 1,300 Sucres/USD for conversion; a.i. = active ingredient

Table 2.3 Workdays by gender and activity in field potato production (by hectare and potato cropping cycle) (1990-1992; n=320 plots) (Crissman et al., 1998b)

Activity	Men	Women	Total
Soil preparation	17.1	0.1	17.2
Planting	9.2	6.5	15.7
Crop management (excluding pesticide applications)	47.9	2.9	50.8
Pesticide applications	20.2	0.0	20.1
Harvest (sorting, bagging)	38.3	14.5	52.8
Total	132.7	24.0	156.7

Soil and pest management

Sixty percent of potato fields are prepared exclusively by tractor, and 25 percent are ploughed via a combination of oxen and by hand (Veen, 1999). The remaining 15 percent of fields are prepared exclusively by hand. Generally, landscape determines patterns, with farmers relying on mechanised tillage for fields of less than 35 percent slope. Chemical fertilisers have replaced traditional means of managing fertility, such as rotations and extended fallows (Crissman et al., 1998b; Barrera et al., 1999). Essentially, all potato growers in Carchi used chemical fertilizers, with an average application rate being 138 kg/ha of Nitrogen (N), 327 Phosphorus (P), and 163 Potassium (K) (Table 2.2). The compound fertilizer 18-46-0 (18% N, 46% P, and 0% K), that responded to a phosphorous tie-up problem of black Andean soils, was the most common product applied. While still economically cost effective, according to aggregate soil analysis, fertilizer use was between 50 and 100 percent above recommended rates for potato (Pumisacho and Sherwood, 2002).

Scientists have identified hundreds of insects and pathogens (biotic disease agents) that feed on potato (Pumisacho and Sherwood, 2002). Some of these co-evolved with the crop. Because the potato typically is propagated a-sexually by means of tubers, it was relatively easy for pests to travel with the crop as it migrated from the Andes to Europe and the rest of the world. Other pests and diseases existed locally and adapted to the potato when it arrived as a new host plant. In Ecuador, a large number of insect and disease pests attack potato, but in Carchi most damage is caused by three: the disease late blight (caused by the fungal-like pathogen *Phytophthora infestans*), the Andean weevil (*Premnotrypes vorax*), and the recently introduced Guatemalan tuber moth (*Tescia solinavora*). Additionally, a complex of minor foliar pests feed on the crop, including leaf flea beetles (*Epitrix* spp.), aphids (*Myzus persicae* and *Macrosiphun euphorbiae*), thrips (*Franliniella tuberosi*), and leafminers (*Liriomyza huibodrensis*).

An exotic pathogen from North America and Europe causes the devastating disease late blight. The pathogen was likely introduced to the Andes on seed tubers in the early twentieth century, most likely via Europe, after it had contributed to the Irish Potato Famine in the early 1840s (Andrivon, 1996). *P. infestans* is an oomycete, fungal-like organism that infects vascular tissues, producing blight symptoms (known in the Andes as *lancha* or *rancha*) in solanaceous crops (de Bary, 1876). Many plant pathologists consider late blight the most economically severe disease on edible crops the world over (Fry, 1997). The pathogen can enter a field and devastate a potato crop in less than one week.

In Ecuador the disease proliferates at altitudes between 2,800 and 3,400 masl (Pumisacho and Sherwood, 2002). Studies have found that the pathogen can travel with the wind hundreds of kilometres, limiting the usefulness of rotation with non-hosts as a management strategy. In humid and cool conditions common to Carchi, spores germinate and hypha penetrate the lamina of leaves, reproducing both a-sexually and sexually in a matters of hours and destroying tissue. The pathogen interferes with photosynthesis, thereby decreasing plant growth and yields. Similarly, *P. infestans* also can directly infect fruits and tubers. Under the right conditions the oomycete can live and reproduce in the soil and infect tubers in the ground. For reasons not entirely understood, this means of infection is less common in the Northern Andes, perhaps due to biological or chemical antagonism of soils (Garzón-Villalba, 1998). As a result of favourable environmental conditions for late blight in the highlands and the difficulty of producing multiple gene resistance in potato, the pathogen commonly overcomes resistant varieties in less than five years. As a result, control strategies in Carchi largely have centred on the use of foliar fungicides targeting spore germination and hyphal penetration of leaves.

The Andean weevil, locally known as *gusano blanco* or the white worm, is an endemic insect that co-evolved with potato (Gallegos et al., 1997). In the highland provinces of Ecuador its larval stage commonly affects between 20 and 50 percent of tubers, causing considerable economic loss for farmers. The small adult beetle survives above ground for about 270 days where it feeds on the leaves of potato and other solanaceous relatives, causing limited foliar damage. During this period females lay about 260 small white eggs, usually at the base of plants. After about 35 days the eggs hatch into small white larva that live in the soil for about 38 days, where they burrow into potato tubers and produce elongate galleries. The insect passes through pre-pupa (18 days) and pupa (26 days) stages in a small dirt cell in the soil and sometimes the potato tuber, before the adult emerges and escapes to the soil surface. Adult weevils have highly developed olfaction and may travel three to five kilometres in search of host plants. They can survive for three months without food. In Carchi, where potato production is continuous, the Andean weevil is omnipresent, and the different life cycle stages of the insect can be found in fields at any given time of the year (Pumisacho and Sherwood, 2002). Traditionally, the Andean weevil was controlled empirically through multi-cropping and crop rotation. Certain cultural practices, such as prolonged rotations with non-host crops, companion planting with chocho, as well as the *wachu rozado* reduced tillage system, were antagonistic to the beetle. Intensive potato production increased the presence of potato as a host plant and has contributed to the proliferation of the pest in recent time. Since larva live in the soil, they are difficult to observe and control. Tillage can decrease populations, but it also synchronizes life cycles of surviving beetles with the crop. The beetle is small and dirt-like, making it difficult to perceive, and as a result, knowledge of the insect's life cycle generally has not entered into rural knowledge systems. As a result, farmers have come to rely on soil drench and systemic insecticides that translocate in plants and poison larva at the moment they burrow into tubers.

In 1983, the Guatemalan tuber moth or *Tescia* migrated into South America via a contaminated shipment of potato seed from Costa Rica to Venezuela. In 1985, it arrived in Colombia via similar means and, subsequently in 1996, reached Ecuador (Barragán et al., 2000). Five years later the pest was found in potato fields and markets throughout Ecuador and northern Peru. The adult moth lays between six and 15 white eggs at the base of potato plants. Over a course of 12 to 15 days, eggs turn yellow and then purple before hatching (Pumisacho and Sherwood, 2002). Larva develop in the soil over a period of 30 to 35 days, when they search for and infest tubers, leaving behind galleries. Typically larvae abandon the potato at maturity to form a cocoon in the soil, but it also may pupate in the potato itself or in sacks during transport and storage. After between 28 to 30 days a grey moth adult emerges, which lives for 18 to 22 days. During this period, females lay about 250 eggs. The adults feed on plant exudates, but they can survive without eating. Exotic to the Andes, the Guatemalan tuber moth does not have natural enemies in Carchi. Frequent rainfall effectively suppresses moth populations, but during a dry year the pest can recover to devastate crops. In 1998, field infestations in Carchi were so bad that many farmers chose not to harvest their potatoes, which contributed to further proliferation of the insect. Farmers have not yet developed cultural means of managing the pest, but rotations with non-host crops can starve out larva in the soil. Nevertheless, adults can easily travel the distances between potato fields in Carchi, so clean fields quickly become infested. Farmers commonly apply systemic soil as well as foliar insecticides for the control of *Tescia*, but these have little affect on the insect (Chamorro et al., 2004).

The earlier mentioned complex of foliar pests does little economic damage to the potato crop in Carchi largely as a result of frequent rainfall, which controls adults as well as larva and nymphs on leaves (Pumisacho and Sherwood, 2002). Even during dry periods the damage to leaves, while visibly impressive, rarely influences production. Nevertheless, over the years farmers have come to view any presence of insects on their crop as threatening, so local understanding of "good farming" has evolved to include regular applications of highly toxic foliar insecticides (Espinosa et al., 2003).

<u>Pesticide use</u>

Farmers in Carchi invest three times more money on pesticides in potato than they do on any other crop (Table 2.4) (Crissman et al., 1998b). When the products and labour are factored, pesticides represent about 33 percent of total production costs. In the early 1990s farmers applied 38 different commercial fungicide formulations (Table 2.5). Barrera et al. (1999) found essentially the same patterns at the end of the decade. Farmers apply 24 active ingredients of fungicides. The class of dithiocarbamate contact-type fungicides are the most popular, with mancozeb contributing more than 80 percent by weight of all fungicide active ingredients used. The dithiocarbamate family of fungicides has recently been under scrutiny in the Northern Andes due to suspected reproductive (Restrepo et al., 1990) and mutagenic effects in human cells (Paz-y-Mino et al., 2002). Governments in Europe and the United States have raised similar concerns over these fungicides (USEPA, 1992; Lander et al., 2000). In summary, 80 percent of the fungicides applied in Carchi contain a suspected cancer-causing agent.

Farmers use three of the four main groups of insecticides in 28 different commercial products. Although organochlorine insecticides can be found in Ecuador, farmers in Carchi do not use them. The carbamate group is represented only by carbofuran, but this is the single most heavily used insecticide - for control of the Andean weevil as well as for the Guatemalan tuber moth, though carbofuran does not control *Tescia*). Farmers exclusively apply a liquid formulation of carbofuran, which is restricted in North America and Europe due to the ease of absorption and the high acute toxicity of the pesticide. While the manufacturer recommends just one application of carbofuran for potato, many farmers apply more than ten applications. Another 18 different active ingredients from the organophosphate (OP) and pyrethroid groups are employed to control foliar pests, though only four are used on more than ten percent of plots. Here the OP methamidophos, also restricted in North America due to its high acute toxicity, is the clear favourite. Carbofuran and methamidophos, both classified by the World Health Organization (WHO) as highly toxic (1b) insecticides, respectively make up 47 percent and 43 percent of all insecticides used (by weight of active ingredient applied). In summary, 90 percent of the insecticides applied in Carchi are highly toxic.

Table 2.4 Pesticide expenditures for different crops Carchi (US$/ha) (1990-1992; n=40 farmers) (Crissman et al., 1998b)

Crop	Fungicide	Insecticide	Total
Potato	128	60	188
Wheat	48	4	52
Fava bean	33	19	52
Barley	46	1	47
Peas	23	10	33
Maize and field bean	15	14	29
Maize	12	14	26
Melloco[a]	b	10	10
Oca[a]	b	b	b

[a] Melloco and oca are Andean root crops

[b] No pesticides were applied

Most insecticides and fungicides come as liquids or wetable powders and are applied by mixing with water and using a backpack sprayer. Provided the costs associated with spraying, farmers usually combine several products together in mixtures known as cocktails, applying all on a single pass through the field. On average, each parcel receives 6.7 applications with 2.5 insecticides and fungicides in each application (Crissman et al., 1998b). On many occasions, they mix different commercial products containing the same active ingredient or different active ingredients intended for the same type of control. Women and very young children typically do not apply pesticides – among the 2,250 applications that CIP documented in its 1990s' studies, women made only four.

Table 2.5 Pesticide use during a single potato cropping season (1990-1992; 320 plots) (Crissman et al., 1998b)

Fungicides	Amount applied (kg)	No. of applications	No. of plots treated
Mancozeb[a]	3,110.67	1,801	304
Sulphur compounds	333.14	286	99
Propineb[a]	142.02	146	53
Maneb[a]	115.11	181	65
Cymoxanil[b]	64.93	635	178
Copper compounds	29.21	94	29
Fentinacetate	11.34	86	36
Ferbam[a]	9.55	73	28
Chlorotalonyl	6.75	6	6
Fosetil–aluminum	4.74	11	6
Metiram[a]	3.92	7	6
Oxicarboxin[b]	1.95	2	2
Propiocanazol[b]	1.39	26	13
Captan	1.16	7	5
Methyl tiophanate	1.15	12	5
PCNB	0.75	1	1
Dinocap	0.59	5	3
Tridemorf[b]	0.30	2	1
Zineb[a]	0.25	3	2
Carbendazim[b]	0.25	1	1
Carboxin[b]	0.15	1	1
Ofurace[b]	0.02	1	1
Metalaxyl[b]	0.00	1	1
Insecticides	**Amount applied (kg)**	**No. of applications**	**No. of plots treated**
Carbofuran	224.77	687	262
Methamidophos[c]	206.69	999	265
Profenofos[c]	20.99	117	62
Fonofos[c]	9.77	28	16
Malathion[c]	9.72	14	9
Dimetoato[c]	5.40	19	11
Lambda	0.78	148	64
Cihalotrina	0.72	3	1
Diazinon[c]	0.71	10	6
Forato[c]	0.49	4	1
Methyl parathion	0.46	92	42
Deltametrine	0.32	2	2
Monocrotophos[c]	0.32	1	1
Phosfamidon	0.31	7	4
Cypermetrina	0.19	7	2
Acephate	0.12	10	6
Cyflutrin	0.08	1	1
Formothion	0.08	1	1
Fenitrothion[c]	0.05	3	2
Alfametrina	206.69	999	265
Methamidophos[c]	20.99	117	62

[a] Dithiocarbamate fungicide; [b] Systemic fungicide; [c] Organophosphate insecticide

Ecuador's exchange rate policies during the 1980 and 1990s effectively subsidized the importation of pesticides, including the highly toxics carbofuran and methamidophos, by about 30 percent (Lee and Espinosa, 1998). Econometric evaluations of pesticide use in Carchi potato production found that from a financial perspective farmers used the products efficiently (Crissman et al., 1994). Four mathematical approaches were considered in estimating production elasticity of specific inputs, which showed the overall marginal productivity of pesticides to be about 12 percent (Table 2.6). Due to the virulence and aggressiveness of the late blight pathogen, plant pathologists consider the use of fungicides as essential for obtaining potato harvests, so the return of fungicides is consistent and high. Attempts during the 1990s by an environmental NGO to produce pesticide-free potatoes in Carchi failed and affirmed this point of view (Frolick et al., 1999). In summary, the benefit to yields (and revenues) from using pesticides exceeds the additional costs of using them.

Table 2.6 Elasticity estimates for pesticides used in potato production in Carchi (n=320 plots) (Crissman et al., 1994)

	Functional form*			
Input	**Cobb-Douglas**	**Quadratic**	**Exponential**	**Logarithmic**
Fungicides	0.0827	0.1148	0.0000	0.0000
Foliar insecticides	0.0217	0.0268	0.0017	0.0010
Soil insecticides	0.0501	- 0.0038	0.0557	0.0595

*Note: Exponential and logarithmic forms were specified with a reduction restriction as suggested by Lichtenberg y Zilberman.

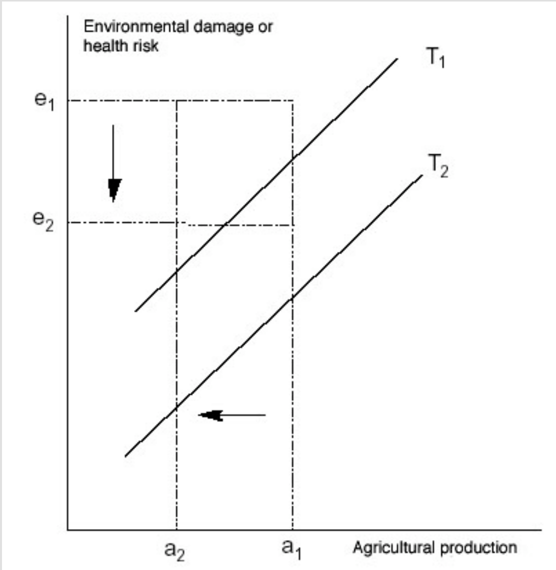
Environmental and health costs of modern agriculture

While a conventional economic analysis of the employment of technologies in agricultural production in Carchi showed positive returns – i.e., the benefit of increasing productivity through fertilisers or mechanised tillage or reducing losses due to pests and diseases exceeded costs – that same use could cause adverse environmental and health effects. The previously mentioned elasticity studies on pesticides, for example, showed that pesticide use was efficient from a narrow farm production perspective. Nevertheless, that study examined pesticide use solely from the perspective of reducing crop losses. When adverse health and environmental effects are included in productivity analyses, results can be very different.

The researchers developed an integrated assessment method to address this analytical problem called the Tradeoffs Analysis Model (ToA) (Antle et al., 1998; Stoorvogel et al., 2003) (Box 2.1). Interest in developing the model and further understanding the true costs of modern agriculture led to further environmental and health investigations. The ensuing research primarily looked at different environmental concerns around human-induced soil degradation as well as health concerns associated with pesticide exposure. Outcomes contributed to integrated analysis of productivity, health, and environmental tradeoffs of different technological alternatives and policy recommendations.

Box 2.1 Tradeoffs analysis of sustainable agriculture and the environment in the Andes: A decision support system for policy makers

Since 1996, CIP, in collaboration with INIAP, Montana State University (MSU), the *Pontífica Universidad Católica de Ecuador* (PUCE) and Wageningen University and Research Centre (WUR), among other organisations, have implemented a collaborative project to provide a decision support system for assessing tradeoffs between agricultural production and the environment for different economic, agricultural and environmental policies, and agricultural research. Through quantifying relationships between key economic and health or environmental indicators, the Tradeoffs Analysis Model (ToA) uses raw data and software to compare different technological alternatives, in search of potential positive sum or "win-win" scenarios.



The diagram graphically explains the tradeoffs concept. Increasing from zero, the vertical axis registers levels of growing negative impact on the environment or health. The horizontal axis presents growing value of agricultural production. Changes in technology that increase production commonly lead to increased affects on the environment or health, as demonstrated by the climbing rate of the curves. Nevertheless, a shift to certain technology, for example from pesticides to IPM, can produce movement from T_1 to T_2, by decreasing negative environmental or health effects while maintaining production. The result is a win-win development. Details on ToA are available at the project website (www.tradeoffs.montana.edu) and the model website (www.tradeoffs.nl).

In the Andes, the development and application of ToA has concentrated on pesticide and soil management technology. The combination of economics, soil science research, and crop and dairy modelling advances methodological development of a conceptual model that links economics and environmental research for the purpose of policy analysis and technology evaluation. A product development team aims to continually integrate developmental research, strategic research and outreach activities. The adaptation of the decision support system represents developmental research that has required the utilisation of existing secondary information from sources such as soil survey, land use survey, weather, farm production, and economic data. As the decision support system has developed, the initiative has encouraged outreach through the training of "change agents" from NGOs and local governments in transmitting results and providing feedback links with on-going policy dialogue.

Soil degradation

De Noni and Trujillo (1986) identified Carchi as a region of rapid soil decline. In their work on different aspects of soil modelling for the broader ToA effort, Kooistra and Meyles (1997) and van Soest (1998) from Wageningen University raised concerns over the soil erosion provoked by potato cultivation. These scientists were alarmed to see subsoil *cangahua* emerging at the top of hillsides after three decades of tractor use. Due to the high water holding capacity of black Andean soils, Kooistra and Meyles (1997) surmised that soil loss was primarily due to mechanized tillage on slopes and not run-off due to rainfall.

Subsequent quantitative studies confirmed these observations. Veen (1999) examined on-farm soil movement in the San Gabriel area and found that the primary factors behind soil degradation and production declines were: longer production history, intensification of production, the use of modern technologies, and tractor applications. Valverde et al. (2001) documented soil displacement produced by ploughs and disks in Carchi potato production. They found that mechanised tillage in a potato field commonly displaced between 50 and 100 t/ha of soil, with a displacement of greater than 80 t/ha common in slopes over 25 percent.

A dominant pattern of market-oriented production and the positioning of potato as a cash crop led to an intensification of agriculture in Carchi. In practice, this signified a shift towards total tillage, mono-cropping, shortening of fallow periods, and agrochemical use. The CIP researchers surmised that this affected "soil health" – i.e., the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health.[2] Between 1999 and 2003, INIAP and CIP conducted a joint study in Carchi on the effects of potato farming on soil regenerative capacity through a project named Eco*Suelos* (in English, EcoSoils).[3] While the researchers had a difficult time understanding the dynamics of soil ecology in such a short period of time, preliminary results pointed to worrisome trends in long-term soil health. Changes to soil micro-morphology, such as soil organic matter fractions, nutrient content, and water-holding capacity, were not observed. Nevertheless, the research identified a change in soil environmental conditions and ecology that appeared to work against long-term crop health and overall sustainability of agriculture. Pathogenic nematode populations (*Globodera* or *Meloidogyne* spp.) were found to be relatively low, most likely due to heavy use of carbofuran (both an insecticide and nematicide). Using *Rhizoctonia* and *Fusarium* spp. as indicators, studies found that modern agriculture practices (i.e., total tillage, mono-cropping, shortening of fallow periods, and agrochemical uses) in potato production combined to contribute to the proliferation of soil pathogens. Further, they found that native mycorrhizae populations declined, decreasing the plants' ability to absorb soil phosphorous, thereby potentially affecting root development and overall crop growth and production. While studies were not conclusive, it was suggested that beneficial

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[2] Harris and Bezdicek (1994) explain the difference between "soil quality" and "soil health." Uphoff and Sherwood (2000) argued in favour of soil health in the context of regenerative agriculture, due to its conceptual emphasis on the dynamic qualities of soil and inclusion of socio-technical aspects of agriculture.

[3] "Eco*Suelos*: investigacion para un manejo mas productivo y sostenible de suelos andinos en la ecoregion centro-norte del Ecuador" was a collaborative INIAP-CIP project funded by MAG/PROMSA, IQ-CV-049.

entomopathogen populations had declined, contributing to the proliferation of a major pest: the Andean weevil.

Box 2.2 *Wachu rozado*: a pre-Colombia reduced tillage potato system

During a first trip to Carchi, Joel,[4] the head of the INIAP-Carchi, took me on a drive in the project truck to visit some potato fields located on the hillsides above the town of San Gabriel. Along the way, I spotted what looked to be a farmer planting potatoes on a steep slope of pasture. I asked Joel to stop, and we entered the field to talk with the farmer. The farmer explained that he was planting in *wachu rozado*. The term was an odd mixture of the Kichwa word *wachu*, meaning furrow, and the Spanish *rozar*, to cut; literally, *wachu rozado* meant "cut furrow." I came to learn that *wachu rozado* probably was a pre-Colombian tillage system for roots and tubers that appears to have developed in moist highland areas such as the *páramo* Andes.

We conducted a brief follow-up study to better understand the system (Sherwoood, 1998). *Wachu rozado* involved cutting and folding over two parallel rows of sod towards one another. The potato crop was cultivated where the line of folded over sod flats met. Farmers claimed that *wachu rozado* was more productive than conventional tillage. They also said that it reduced soil erosion, and the crop had fewer problems with late blight. They claimed that the potatoes came out cleaner and with less damage due to the Andean weevil and potato scab. Despite the thousands of hectares of *wachu rozado* that remained on the surrounding hillsides of the region and the well-known problems of soil erosion, the national research service in Ecuador had overlooked the system.[5]

Further research confirmed what farmers had been saying all along (INIAP-CIP, 2003). Economic studies demonstrated that *wachu rozado* was more cost-effective than hand tillage and it compared with conventional tractor tillage. It was also an important source of employment, demanding 25 more labour days/cropping season than conventional tillage. Soil displacement under *wachu rozado* was considerably less than under conventional tillage (about 15 vs. 40 t/ha). Additionally, *wachu rozado* produced "cleaner" potato tubers – dirt-free and with less *Rhizoctonia* and Andean weevil damage. Apparently, the "heating up" of the sod mat in decomposition was antagonistic to soil pests. Research trials showed that under equal fertilization regimes *wachu rozado* out produced conventional tillage (24.13 vs.19.52 t/ha), most likely due to increased mycorrhizae development and improved phosphorus uptake. Under *wachu rozado*, the potato crop grew on a high ridge and had better drainage than with conventional tillage, leading to lower relative humidity around the plant. As a result, comparative trials found less severity of late blight infection (AUDPC of 471.44 for *wachu rozado* vs. 629.55 conventional tillage). *Wachu rozado* proved to be both highly productive and resource conserving – a rare combination. Paredes (in process) provides further analysis of the survival of the wachu rozado system.

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[4] In this dissertation, I apply fictitious names to local actors to protect the reputation of individuals.

[5] This is in contrast to CORPOICA, the Colombian national research service. During the 1990s CORPOICA's Nariño station had developed a research program on *wachu rozado*. Pedro Oyarzun, Trip report on visit to CORPOICA research station at Obonunco, Nariño, 17-20 March 2001.

The combined effects of massive soil erosion through mechanised, total tillage on hillsides and a decline in soil health led Pedro Oyarzun, a soil scientist and co-leader of INIAP's National Potato Program to conclude, "Unquestionably, soil degradation [in Carchi] is the primary environmental concern of the province and a major threat to agricultural sustainability and livelihoods."[6] In contrast, research on the surviving pre-Colombian *wachu rozado* system suggests that traditional soil management was far more resource conserving (Box 2.2)

Generation of pest problems

> Years ago, we did not need to apply pesticides, but people said that a man who lived close to this place started [to apply] first. It seems that the worms came from the products, because after that, the pests began to increase. As a result, it is no longer possible to produce without [pesticide] applications. – a smallholder farmer from Carchi

Essentially every farmer with whom I have talked since arriving to Carchi has made the same general claim: pest problems are getting worse with time. When I first arrived they spoke of two major pest problems: the Andean weevil (*Premnotrypes vorax*) that could decrease yields by as much as 80 percent and late blight (caused by *Phytophthora infestans*) that could entirely decimate production (Crissman et al., 1998; Yanggen et al., 2003). By 2000, they added a third major pest: the Guatemalan potato moth (*Tescia solanivora*), which has caused a large number of farmers in drier areas to abandon potato farming (Barragán et al., 2000). This modern proliferation of pests is no accident, but rather the direct result of changes to agroecologies associated with intensification of agriculture and the introduction of exotic organisms (Frolick et al., 2000; Dasgupta et al., 2002).

As explained earlier, the Andean weevil is an endemic insect that co-evolved with potato (Gallegos et al., 1997). The intensification of potato production in time and space created a favourable niche for the proliferation of this insect to the point where it became a major pest. Meanwhile, late blight is caused by an exotic fungal-like organism that was introduced via seed shipments between Europe and the Andes in the early 1900s (Andrivon, 1996). Similarly, the exotic Guatemalan potato moth (*Tescia solanivora*) arrived in Carchi in 1996 via the introduction of seeds from Colombia and occasionally decimates crops, particular during dry years (Barragán et al., 2000).

Further, the wide adoption of non-specific pesticides has disrupted natural mechanisms of control, thereby favouring the proliferation of insect pests and diseases as well as causing the emergence of a handful of secondary pests (Pumisacho and Sherwood, 2003). For example, the leafminer fly *(Lyriomisa quadrata*), an endemic insect that was kept in check through naturally occurring parasitism, became a major pest in the mid-1990s, causing occasional yield losses of up to 40 percent and leading farmers to increase insecticide applications. As a result of the ecological disturbances of modern agriculture, *Carchense* farmers find themselves on a "pesticide treadmill," as described by van den Bosch (1977).

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[6] Personal communication during INIAP/PNRT Yearly Evaluation and Planning Meeting, Ambuqui, 15 October 2001.

Pesticides have not only become a necessary part of the production system, but each year farmers must make a larger number of applications to sustain production.

Pesticide effects

> My husband usually does not take a shower after pesticide applications. I believe that he has lost his sense of smell, because he is not able to smell pesticide residues on his clothes or body anymore. Nonetheless, after applications I can smell a very strong pesticide smell coming off his body... and I have to sleep with this! – a mother from San Pedro de Piartal, quoted in Mera-Orcés (2000: 21)

From previous activity in Central America and the Philippines (Cole et al., 1988 and Antle et al., 1995), the researchers were well aware that the effects of pesticides were not limited to the fields where they were applied. Pesticides were carried in the environment and reached homes and people, leading to potentially costly environmental and health consequences.

Studies on the environmental effects of pesticides have drawn on a variety of indicators to assess the mobility of chemicals in the environment (Table 2.7). For example, methamidophos, cymoxanil and carbofuran are highly soluble in water, which can increase their mobility in the environment. The Koc indicator measures the affinity with which a chemical absorbs to soil carbon – the higher a Koc value, the stronger a chemical's tendency to fix to soil. Carbofuran and methamidophos have relatively low Koc numbers, signifying that these products do not fix to soil carbon, and therefore they are highly mobile in the soil. A long half-life of a pesticide signifies that a chemical breaks down relatively slowly and thus is highly persistent in the environment, thereby prolonging potential harm. Mancozeb, maneb, carbofuran and fonophos each have long half-lives and are relatively persistent pesticides.

Table 2.7 Selected properties of pesticides commonly used in potato production in Carchi (Stoorvogel et al., 2003)

Pesticide	Half life (days)	Koc (mL/g)	Water solubility (mg/L)	Long-term human toxicity (mg/L)	Long-term fish toxicity (mg/L)	Short-term fish toxicity (mg/L)
Carbofuran	50	22	351	40	18	387
Cynoxanil	5	391	800	91	1.53	600
Fonophos	40	870	17	10	3.5	3045
Mancozeb	70	2000	6	6	3.17	6335
Maneb	70	2000	6	6	0.0019	3.86
Methamidophos	6	5	1,000,000	7	165	826
Profenos	6	2000	28	0.35	2.9665	5933

The research team surmised that carbofuran had significant environmental effects, so it became the focus of attention. Jaramillo (2000) and Jaramillo et al. (2001) presented the research on carbofuran leachate in soil, groundwater, and surface water in and around potato fields in Carchi. While the research validated the effectiveness of the Leaching

Estimation and Chemistry Model (LEACHM), it did not find exceedingly high rates of carbofuran in water sources. Carbofuran was found in soil leachate, groundwater, and surface water samples, but concentrations were at 0.4 ppb, well below the Maximum Contamination Level permitted by the US Environmental Protection Agency (40 ppb). In light of the high use of carbofuran in potato production, it was concluded that the low concentrations were due to the unusually high organic matter content of Carchi soils and their potential for rapidly degrading pesticides.

Kosten (2001) studied the effects of carbofuran on three families of benthic aquatic macro-invertebrates in the field and in streams. While she detected carbofuran concentrations in all six water bodies studied, she did not find conclusive evidence of structural change in soil ecologies associated with carbofuran. This may have been due to previous species selection as a result of exposure to carbofuran, which could lead to resistance build-up. The study suggested that resistance might have been a factor, since immobilization of invertebrates by carbofuran in Carchi was 1,000 times that found in other studies.

Most of the CIP-led research concentrated on pesticide management, exposure conditions, and ensuing health effects. Based on survey, observational and interview data, farmers generally purchased pesticides by commercial names (Espinosa et al., 2003). Only a small minority of farmers reported receiving information on pesticide hazards and safe practices from vendors. Pesticide storage was relatively brief (days to weeks) but occurred close to farmhouses because of fear of theft. Farmers usually mixed pesticides in large barrels without gloves, resulting in considerable dermal exposure (Merino and Cole, 2003). Smallholders and, on larger operations, day labourers applied pesticides using backpack sprayers on hilly terrain. Few used personal protective equipment for a variety of reasons, including social pressure (e.g., masculinity has become tied to the ability to withstand pesticide intoxications), as well as the limited availability and high cost of equipment. As a result, pesticide exposure conditions were high. During applications, most farmers wet their skin, especially the back (73% of respondents) and hands (87%) (Espinosa et al., 2003). Field exposure trials using patch-monitoring techniques showed that considerable dermal deposition occurred on legs during foliage applications on mature crops (Cole et al., 1997b).

Subsequent studies found that family members were chronically exposed to low quantities of pesticides in their homes and at work through a multitude of contamination pathways (Merino and Cole, 2003). Excess mixed product was applied to other tuber crops, thrown away with containers in the field, or applied around the house. Clothing worn during application was often stored and used repeatedly before washing. Contaminated clothing was usually washed in the same area as family clothing, though in a separate wash. Extent of personal hygiene varied but was usually insufficient to remove all active ingredients from both the hands of the applicator and the equipment. Separate locked storage facilities for application equipment and clothing were also uncommon. Swab methods found pesticide residues on a variety of household surfaces as well as on farm family clothing.

Active surveillance of hospital records revealed that pesticide poisonings in Carchi were among the highest recorded anywhere (Cole et al., 2000). While there were some suicides and accidental exposures, most poisonings were of pesticide applicators. Clinical studies found that both applicators and their family members were at risk. Exposure to fungicides caused diverse eye and skin disorders, including conjunctivitis and cutaneous and sub-cutaneous effects on the neck, trunk, back, underarms, and genitalia (Cole et al., 1997a and b). Comparisons between urban control populations and farm families found that rural people suffered dermatitis (68% of the at-risk population and 55% of applicators, compared with 31% of the control population, $p < 0.001$), and pigmentation disorders (25% of the at-risk population and 10% of the control, $p < 0.06$). In the case of dermatitis ($n=117$), five percent tested positive for maneb in patch studies for contact allergies. In logistic regression analysis, the significant predictors of dermatitis ($p < 0.1$) included years using fungicides and deficient application practices. Chronic exposure, lack of personal protective equipment, and use of high concentrations of chemicals were associated with incidence of pathologies. Additionally, climatic conditions as well as living and work environments were mentioned as important contributors to disorders. The researchers concluded, "The findings point to fungicides as the most important contributor to the prevalence of dermatitis among the Ecuadorian farming population."

Other studies looked at neurobehavioral disorders caused by the most commonly used insecticides: highly toxic methamidophos and carbofuran. The health team applied a World Health Organisation (WHO) recommended battery of tests to determine the effects of exposure on peripheral and central nervous system functions (Cole et al., 1998; Cole et al., 1997a). The results showed high proportions of the at-risk population affected, including both farmers and their family members. Average performance scores for farm members were a standard deviation below the control sample. The researchers determined that 60 percent of rural people were affected and women, although not commonly active in field agriculture, were nearly as affected as fieldworkers. Alarmingly, both Mera-Orcés (2000) and Paredes (2001) reported that acute poisonings and deaths among infants and young children were common in rural communities, with cases identified in every community studied.

In summary, the medical team concluded that chronic and acute exposure to pesticides resulted in considerable health impacts that ranged from sub-clinical neurotoxicity (Cole et al., 1997a, 1998), poisonings with and without treatment (Crissman et al., 1994), to hospitalizations and deaths (Cole et al., 2000). The human health consequences included poisonings (at a rate of 171/100,000 rural population), dermatitis (48% of applicators), pigmentation disorders (25% of applicators), and neurotoxicity (peripheral nerve damage, abnormal deep tendon reflexes and coordination difficulties). Mortality due to pesticide poisoning was among the highest reported anywhere in the world (21/100,000 rural population). Cole et al. (2002) summarised the pesticide health impacts as a classic epidemiological pyramid (Figure 2.7).

Figure 2.7 Epidemiological pyramid of pesticide health impacts in Carchi (numbers per 10,000 rural population) (Cole et al., 2002)

Acute pesticide poisonings led to significant financial burden on individual families and the public health system (Cole et al., 2000). Median costs associated with pesticide poisonings were estimated as follows: public health care direct costs of $9.85/case, private health costs of $8.33/case, and lost time indirect costs for about six worker days of $8.33/agricultural worker. All of these were over five times the daily agricultural wage of about $1.50 at the time, in 1992. The researchers did not attempt to judge financial valuation of the deaths associated with pesticide poisonings nor the effects of pesticides on quality of life, both of which would substantially increase the estimates of overall economic burden of illness.

Integrated tradeoffs analysis: in search of "win-win" scenarios

Integrated production-health analysis by Antle et al. (1994) found that pesticide use led to serious health consequences that placed into question the economic value of present technology, particularly of highly toxic insecticides. Table 2.8 provides summary statistics on the potato production data. The essential role that pesticides played in crop production was indicated by the positive and significant coefficients on the fungicide, carbofuran, and foliar insecticide variables. Nevertheless, the coefficient on the neurobehavioral health variable was statistically significant at all conventional levels, and its negative sign indicated that farmers with higher neurobehavioral function obtained lower cost of production per hectare and thus higher productivity. The magnitude of the coefficient indicated that the elasticity of cost with regard to health was about -0.15, which was comparable to estimates obtained by Antle and Pingali (1995) with rice growers in the Philippines. This signified that the total quantity of carbofuran applied during the season had a negative effect on neurobehavioral performance. Through modelling, Antle et al. (1998) showed that the use of highly toxic insecticides adversely affected farmer decision-making capacity to a level that would justify worker disability payments in other countries.

Through applications of ToA, the researchers explored a number of potentially positive sum (win-win) policy alternatives. These included a combination of taxes or subsidies on pesticides, price increases or declines in potatoes, technology changes with IPM (in the form of insect traps for the Andean weevil, as explained in Pumisacho and Sherwood, 2001:134-5), and the use of personal protective equipment (Antle et al., 1998; Crissman et al., 2003). The results were examined in terms of farm income, leaching of pesticides to groundwater and health risks from pesticide exposure. Normally, changes in a particular policy or technology generates tradeoffs – as certain factors improve, other factors may weaken. The analysis of pesticide taxes and potato price changes produced such a result. As taxes decreased and potato prices increased, farmers planted more of their farm with potatoes and tended to use more pesticide per hectare. Thus a scenario of pesticide subsidies and potato price increases produced growth in income and increases in groundwater contamination and health risks from pesticide exposure.

Table 2.8 Summary statistics for Carchi potato production data (1990-1992 database; n=219 plots) (Antle et al., 1998)*

Variable	Mean	Standard deviation
Total variable cost (US$/ha)	14.16	0.35
Expected yield (kg/ha)	9.87	0.14
Area (ha)	-0.96	0.85
Mean neurobehavioral score	-1.53	0.94
Fertilizer quantity (kg/ha)	6.31	0.40
Land preparation labour (days/ha)	2.37	0.90
Crop management labour (days/ha)	3.90	0.37
Fungicide quantity	11.90	1.43
Carbofuran quantity (kg/ha)	-0.04	1.12
Foliage pest insecticide quantity	10.42	2.24
Fertilizer price	6.45	0.18
Land preparation wage	7.66	0.31
Crop management wage	7.80	0.27
Fungicide price	-0.97	0.67
Carborfuran price	9.71	0.30
Foliage pest insecticide price	-1.22	1.22

*Note: All variables are in natural logarithms except the mean neurobehavioral score. Fertilizer in total N, P, K applied. Fungicide and foliage pest insecticide quantities and prices were quality adjusted using the hedonic procedures described in Antle et al. (1994).

When health was included in the cost function, a tax levied on carbofuran alone resulted in a negative relationship between the tax rate and average cost. The positive effect of a higher pesticide price would be more than offset by the cost-reducing effect of improved health. The clear policy implication was that reducing carbofuran use could be a win-win proposition. Through modelling, the researchers showed that when exposure to carbofuran was reduced, farmers became healthier and more productive. This was because the productivity gains from improved health outweighed the negative productivity effects of reduced pesticide use. The authors concluded, however, that a policy to reduce all pesticide use would be less efficient and would result in a tradeoff between health and productivity.

Figure 2.8 summarises the result of the ToA scenario comparing the base technology (carbofuran) with IPM in the form of insect traps for the management of the Andean weevil. The vertical axis utilizes carbofuran leaching as a proxy indicator for health risk, as measured in increments of measurement for neurobehavioral standard performance

(MNBS). The graph shows that through adopting the use of insect traps and substantially decreasing use of carbofuran from three to one well-placed application, farmers could effectively control the Andean weevil while decreasing burden to health and without negative consequences to production – a win-win scenario. Further modelling of other scenarios showed that a combination of IPM and protective clothing could produce even more optimal results (Figure 2.9).

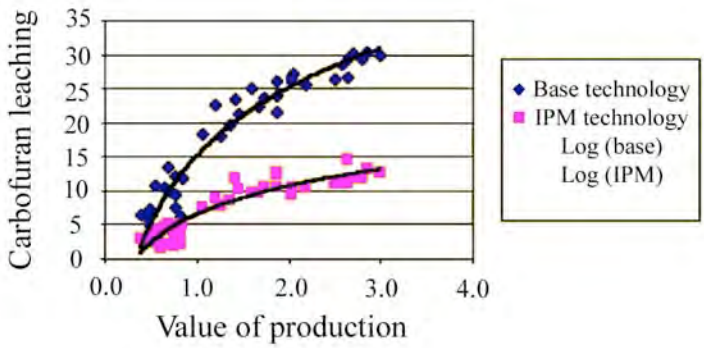

Figure 2.8 ToA outcome comparing two scenarios: base technology versus IPM traps for Andean weevil management (health risk indicator is measurements of neurobehavioral standard performance (MNBS) associated with carbofuran exposure and value of production is net return (x $1,000/ha)) (Antle et al., 1998; Crissman et al., 2003)

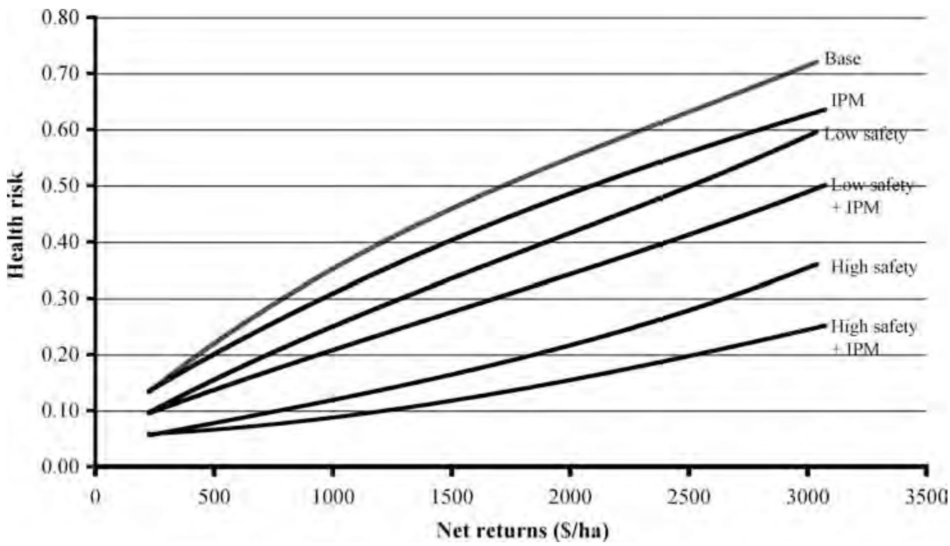

Figure 2.9 ToA outcome comparing different technological scenarios: from base to IPM and Personal Protective Equipment (health risk indicator is measurement of neurobehavioral standard performance (MNBS) and net returns ($/ha)) (Antle et al., 1998; Crissman et al., 2003)

As a result of these findings, the policy recommendations became measures to decrease the use of highly toxic pesticides (through targeted taxes, tighter regulations, or removal from their market), SUP education, and IPM (Antle et al., 1998; Cole et al. 2002; Yanggen et al., 2003). According to Yanggen et al. (2003:195), the investigations on pesticides in Carchi produced two fundamental conclusions: 1) the problems that pesticides cause in health are severe, and they affect an important percentage of the population, and 2) solutions exist that are economically viable and that can substantially improve the health of farmers and protect the environment. The answer was a function of reorganisation around best practice.

Conclusions

Provided its natural endowments, generally educated population, infrastructure and market access, Carchi is potentially one of the most productive agricultural regions of the Andes. Potato farming there has evolved to become a major source of livelihoods, dominating the modern landscape. Through widespread adoption of mechanized tillage and agrochemicals, as well as organisation around commercial markets as a means of financing technologies, potato farming intensified. Provided the resource base and the industriousness of its people, average production in Carchi during the 1990s reached over 20 t/ha -- about three times the national average. On less than a quarter of the country's land area dedicated to the crop, during the 1990s the province came to produce nearly 40 percent of the national potato harvest.

The modern technologies on which farmers came to rely enabled substantial production increases, but they also created pathologies. The multidisciplinary economic, health, and environmental research revealed that modern potato farming did not just produce a lot of potato, it also produced a number of harmful consequences, many of which were hidden from the public eye. Tractors and total tillage displaced between 50 and 100 t/ha during the season. Farmers lost money on over 40 percent of their potato crops. Additionally, exposure to pesticides caused a number of health problems. Nearly half of applicators suffered from skin and eye disorders, such as dermatitis and conjunctivitis. Most worrisome, over two-thirds of the rural population – including men, women, and children – suffered neurological damage to degrees that affected the productivity of their farms. As a result of modern agriculture, Carchi was in the throes of a serious public health epidemic.

Fortunately, alternatives existed. Through integrated economic-environment-health simulation modelling, Antle et al. (1998b) identified rigorously tested best practice for achieving positive sum policy recommendations. The authors demonstrated that combinations of taxes on the most toxic pesticides, pesticide safety education, and promotion of IPM could curb harmful human health and environmental consequences without negatively affecting productivity. My colleagues and I thought that change was primarily a function of educating farmers and policy makers on best practice. Or was it?

Chapter 3

History of Agrarian Development in Carchi: Spanish Arrival, Hacienda System, and Agrarian Reform

Introduction

Beginning with a general description of land use and agrarian society prior to Spanish arrival, this chapter provides a chronology of major historical events leading up to the rise and fall of the hacienda system in Carchi and ensuing agrarian reform. It was beyond the scope of this dissertation to produce a critical analysis of heterogeneous outcomes, such as the unfolding of differential relationships as a result of particular events. Although painted in broad strokes, a look back is useful for understanding how traditional society became uprooted from local context and how thousands of years of relatively stable agricultural development became disrupted. The chapter aims to set the stage of contemporary ecosystem decline on which the master discourse of agricultural modernisation came to be performed.

A number of early Spaniards documented the Incan advance into the Northern Andes in the sixteenth century, including Cieza de León, Cabello de Balboa, Fernández de Oviedo, Sarmiento de Gamboa, Garcilaso de la Vega, Alonso de Borregán, and Gerónimo Aguilar. The Ecuadorian Historical Archive and the Central Bank store these documents, often in original form. Combined with scant archaeology of the ancient cultures of northern Ecuador, this material provided the evidence for the findings asserted in the historical literature on pre-Colombian Carchi and reported here.

In addition to a consultation of the available historical literature, I drew on semi-structured interviews with contemporary *hacendados* (or hacienda owners) as well as their personal libraries and papers. I am particularly grateful to Juan Carlos Landázuri, who was generous in letting me use his hacienda, *La Bretania* in San Gabriel, as a research base during 2002-04. Landázuri introduced me to the "*Grupo de Discusión*," a collective of nine *hacendados* who convened for purposes of cross-learning and technical exchange until 2003, when extortions and kidnappings by irregular armies from nearby Colombia compelled many of them to abandon Carchi.

Pre-Colombian Carchi

Tawantinsuyo, the name of the territory administered by the Incas in the fifteenth century, came to span much of the Andes of present-day Bolivia, Peru, and Ecuador. Although the Incas, under the rule of Túpac Yupanqui in the mid to late fifteenth century and later his son Huayna Capac in the early sixteenth century, only came to politically control present-day Ecuador less than 50 years prior to the Spanish arrival, the region quickly established strong cultural and economic ties with Incan society. By the mid-sixteenth century, the area north of Quito, including the Province of Imbabura, were under initial processes of consolidation, which included the continuation of the Incan trail and military fortresses (*tambos*) as well as the placement of *mitmaq* (or *mitimae*),[1] and state displacement of ethnic groups as a strategy of social control and cultural domination. At that time, the Incan influence further north – over the area of present-day Carchi – was limited to sporadic trade and military expeditions.

As a result, the people of northernmost Ecuador were culturally aligned with the pre-Hispanic groups of Colombia, especially the Capulí and Cuasmal groups that coexisted in the inter-Andean Valley spanning between the Coanque (today, Chota) River in present-day Carchi to the Guáytara River of the Department of Nariño, Colombia, a total area of about 435 km² (Landázuri, 1995). Named the *Pasto* ("Pasture") territory by the Spanish, most likely due to the lush green environment of the North, the Capulí and Cuasmal controlled the area from about 1250-1525. Landázuri explains that today anthropologists commonly refer to both of these groups collectively as "the Pastos."

<u>Land management</u>

Geography, especially altitude, is a major social determinant in the highland Andes. In northern climates, mountain cultures tend to be highly mobile as per seasonal cycles and climate (Grötzback, 1988). While Troll (1968) explained the geographical division between the southern *puna* or dry Andes and the northern *páramo* or wet Andes, Murra (1972) established a theory of vertical control, which explained agricultural and agrarian differentiation along altitudinal belts. In pre-Hispanic time, single ethnic groups of the Andes tended to organize themselves to take advantage of ecological niches of distinct altitudes. Lauer (1993) applied it to the Puna Andes and Salomon (1980) and López-Sandoval (2004) applied the theory to the northern Páramo Andes. Soloman (1980) described the phenomenon of "micro-verticality" in the *páramo* Andes due to the extreme ecological differences in relatively small areas. Micro-verticality explained how different ethnic groups emerged to exploit niches in a communal territory that crossed distinct ecological zones. Micro-verticality allowed people to farm different climatic regimes and return home in a single day. In support of this theory, no nomadic pastoral groups have been found in the *páramo* belt of northern Ecuador, Colombia or Venezuela prior to the Incan and Spanish arrival.

The inter-Andean valley in the Northern Andes runs north and south and lies at between 1,500 and 2,500 meters. Its surrounding hillsides climb to about 3,500-4,500 meters on both the eastern and western ridges. Lying on the equator with fairly evenly distributed sunlight throughout the year, temperature changes are not seasonal, but rather diurnal, with highs and lows determined by altitude. Altitude variability leads to ecological niches, and social organization historically has been influenced by the unique micro-vertical features that determine plant growth and, with the advent of managed ecologies and agriculture, livelihood opportunities.

[1] *Mitimaq* or *mitimae* is the Kichwa term for forced labour parties, usually translocated across geographies.

At the time of the Spanish arrival, coca and maize were the most important crops of the lower and middle elevations (1,500-2,000 m), with coca leaves in high demand throughout the region. Andean roots and tubers (potato, mashua, and olluco) and quinoa were cultivated in highland valleys of altitudes (2,000-2,500 m) (Table 3.1). Farmers managed soil fertility through intercropping, crop rotations, and fallow periods. This included the utilisation of legumes, such as *Lupinus mutabulis* (known in Kichwa as *chocho* or *tarwi*) as well as different field beans (*Phaselous* spp.), in intercropping and rotational systems. Farmers applied manures and other organic amendments at planting. They produced roots and tubers through a reduced tillage regime called *wachu rozado*, which involved cutting and folding over two parallel rows of sod towards one another and planting tubers in the middle of the decaying sod (see Box 2.2).

Table 3.1 Principle crops of the Pastos (Paz Ponce de León (1528) in Landázuri (1995))

Common name (Cuasmal, Kichwa, or Spanish)	**English name**	**Latin name**
Highlands (2700-3000 masl)		
Papa	Potato	*Solanum tubersosum*
Quinua	Quinoa	*Chenopodium quinoa*
Chocho	Lupine	*Lupinus mutabilis*
Oca	Oka	*Oxalis tuberosa*
Mayua o mashua		*Tropeolum tuberosum*
Olluco		*Ullucus tuberosus*
Medium zones (2000-2600)		
Tomate de arbol	Tree tomato	*Cyphomancra betacea*
Mora	Raspberry	*Robus spp.*
Maíz	Maize or corn	*Zea mays*
Paico		*Chenopodium ambrosicides*
Auyama		*Lucubita palmata*
Capuli		*Prunus salidifolia*
Frijol o poroto	Common fieldbean	*Phaseolus vulgaris*
Lowland areas (1500-2000)		
Piña	Pineapple	*Ananas comosus*
Aguacate	Avocado	*Persea spp.*
Yuca	Casava	*Manihot escuelenta crantz*
Frijol o poroto	Common fieldbean	*Phaseolus vulgaris*
Algodón	Cotton	*Gossypium spp.*
Ají	Pepper (spicy)	*Capsicum sp.*
Coca	Coca	*Erythroxylon sp.*

Domesticated animals were limited to guinea pigs and pigs. In contrast to the Puna Andes of the South, llama as a pack animal and source of manure was not present in the North due to the animal's limited adaptability to the wet highlands. The majority of meat and animal products came from hunting wild animals. Remains of small rounded settlements (*bohios*) in the highland areas (circa 3,500 m) suggest that hunting activities occasionally took people to the highland areas. Farming was limited to subsistence needs, and as a result, large areas of forest remained intact.

At the end of the eighteenth century, when French scientists arrived in the area to measure the meridian arcs and the German explorer, Alejandro von Humbolt, was realising his studies that would lead to the founding of the field of geography, dense humid highland forests covered the inter-Andean valley of the Pasto territory. This was in sharp contrast to the non-Pasto areas to the South that had been heavily deforested for centuries. The vast majority of Ecuador's northernmost highland forests fell victim to colonization during the 19th and 20th centuries. Nevertheless, today the western flank of Carchi represents one of the country's largest conservation sites: the El Angel Ecological Reserve that spans several thousand hectares. On the eastern side, the inter-Andean slope boasts an extensive 40,000 hectare stretch of forest that biologists consider one of the few remaining examples of pristine inter-Andean vegetation (Palacios and Tipaz, 1996).

Social organisation, technology, and economy

The tribute documents belonging to Spanish subjects in the mid-sixteenth century and the archaeological explorations reported by Uribe and Cabrera (1977) provide some evidence of social differentiation during the Pasto civilization. Drawing on these sources, Landázuri (1995) concluded that the social organization resembled the *casicazgo* feudal-like structure found in indigenous cultures of Southern Ecuador. The system was led by a relatively wealthy *curaca* or priest, followed by direct family lineage and then by more numerous and poorer agrarian subjects, who commonly paid tribute in the form of crop surpluses in exchange for land rights. Archaeologists found Pasto settlements distributed among locations of fertile soil and following rivers on the inter-Andean valley floor. The largest settlements had up to 12,000 inhabitants. In Carchi, these were: Tulcán, Guaca (today, Huaca), Tuza (San Gabriel), and Mira. These locations are conserved in modern-day gerrymandering, with each representing a principal county seat of the Province's modern-day political structure. The people who inhabit the four communities studied in this thesis most likely belonged to the Guaca (Mariscal Sucre and Piartal) and Tuza groups (Cuba and La Libertad), though more recent settlers continuously migrate from earlier Pasto areas of present-day Colombia.

People inhabited single room, rounded *bohio* structures made of local materials, usually structured of wood, woven with horizontal strips of cane grass mixed with mud, and roofs of highland bunch grass, known as *bahareque* (Oña and Muñoz, 2000). Uribe and Cabrera (1977) studied burial sites in Pupiales, Colombia that consisted of three concentric areas containing patterned series of tunnels. They found higher castes buried in deeper tunnels penetrating to depths of up to 40 m located in the centre and tunnels of lesser depths in the areas radiating outwards. Ceramics found in such burial sites dating back to the early periods of the Pasto civilization were of high quality, demonstrating sophisticated geometric patterns and applying *cire perdu* technology,[2] gold inlays, as well as conch shells from the coast.

It is believed that pre-Incan groups such as the Pastos cultivated plots of about 1,500 m^2, which were large enough for subsistence production and meeting *curaca* tribute payments

[2] A bronze casting following the method of heating wax to let it run away out of casts and then using molten bronze to fill the space.

(Rostworowsky, 2001). Hand tools likely included a version of the Incan *chacqui taclla*, a foot-driven wooden shovel used for turning over soil, and a large wooden mallet used to break up grass clods (Landázuri, 1995). Early farmers used a dibble stick for planting maize. There is no evidence of field irrigation structures in medium to high elevations, where the climate is generally humid and rainfall well distributed. Maize production took place at lower elevations (1,500 to 2,500 masl) and generally near rivers, where farmers likely applied gravity-fed irrigation. Knapp (1992) identified a pre-Hispanic irrigation canal at Pimanpiro (Chapi) in the Chota Valley of unknown origin that was likely constructed by early Pasto groups. Crop health likely was managed empirically through crop rotations, intra- and inter-specific plant biodiversity, mounding and reduced tillage systems, as well as fallow periods of at least five years (Thurston, 1992; Landázuri, 1995; INIAP-CIP, 2003). The lack of storage capacity of potato and limited area appropriate for maize cultivation affected Pasto capability of surviving catastrophes, due either to natural disasters or war (Landázuri, 1995). Poor storage capacity also may have constrained capacity for wealth accumulation and redistribution in the region.

As evidenced by the absence of irrigation infrastructure and constructed roads, labour was characteristically non-collective. It is believed that the Pasto civilization had a degree of labour differentiation. This included a degree of unbalanced reciprocity that demanded political administration controlled by the *curaca*. Commoner households were dedicated to general agriculture for sustenance and tribute. Specialization was limited to textiles. Due to the absence of a labour force, particularly during harvest periods, the *curaca's* were resistant to subject mobility (Grijalva, 1937). Uribe and Cabrera (1977) found remains of cotton textiles in tombs, which may suggest an advanced artisan tradition. Nevertheless, while such textiles were valued during tribute payment, small quantities suggest that industry was limited to home enterprises organized for subsistence use rather than for trade outside the territory.

Salomon (1980) argues that barter exchange existed, especially for storable maize, coca, and cotton. Reciprocity was achieved through labour, cultivated products, textiles, and land access rights. Landázuri (1995) proposed three forms of trade: balanced exchange of goods and labour between households, within multiple households of family lineage, and unbalanced trade between *curaca* and subject in the form of labour and good in exchange for access to land, as per the subsistence needs of the *curaca*. It is assumed that this relationship led to political stratifications, defined by family lineage and articulated through access to privileged goods, especially coca leaves, maize, and gold. Households had direct access to basic subsistence crops – potato and maize – while trade enclaves composed of multi-ethnic groups controlled the exchange of prestige commodities – coca, cotton, salt, and metals – that were centred in the Chota and Guáytara valleys. While these were distributed within the Pasto civilization, the majority was exchanged with groups from the Amazon basin and the Southern highlands in exchange for exotic goods, such as fruits, textiles, and metal products. The *curaca* controlled *mindales* (merchants) who administered exchange agreements and received special status within the political structure of the territory that limited their service to tribute payments, but did not include subjection for agricultural production.

Landázuri (1995) applied the methodology of Polanyi et al. (1976) regarding material reciprocity, geographic distribution, and market commerce as central factors of social organization. Drawing on existing historical records, he concluded that ecological and economic potential determined social differentiation. Coca was the most prestigious and profitable crop of the period and was grown by relatively well-off farmers of Andean lowland areas, followed by maize that grew at medium altitudes, and then tubers grown by small populations of farmers relegated to the highlands, which were vulnerable to frost and hail. In contrast to the *Puno* Andes to the south, the *Páramo* Andes had higher temperatures and humidity and thus it was not possible to convert potato to storable freeze-dried *chuño*, useful for surviving dry spells, travel, and war. As a result, in the Northern Andes maize had a comparative advantage. Nevertheless, because of the limited dry ecological zones appropriate for its cultivation, access to areas adequate for maize cultivation was valued and controlled. In contrast, areas appropriate for potato cultivation were more abundant and less restricted. Landázuri concludes that it is likely that social differentiation for the agrarian class was expressed in entitlements, especially access to land for coca and maize and mobility for crop production.

Depopulation

While it is believed that the Incan ruler Tupac Yupanqui reached Pasto territory between about 1450 and 1480, excursions at that time were not violent but limited to trade interests. The Incan ruler Huayna Cápac reigned over Tawantinsuyo from 1480 to 1525. He entered Pasto territory during his final military campaign, after conquering the Caranquis and Cayambis in a series of violent battles that ended at the site of what became known as Yahuarcocha (Kichwa for "Lagoon of Blood"), just south of present-day Ibarra (Ramón, 1987). Huayna Cápac and his army then continued north with little resistance from the Pasto to the Angasmayo River, located deep in Pasto territory in present-day Colombia, where they established defensive military enclaves. The lack of a Pasto military suggests that the diverse groups were relatively autonomous and not politically aligned to a larger confederation (Landázuri, 1995; Rostworowski, 2001). The Angasmayo River represented the northernmost reach of Tawantinsuyo. Afterward, Huayna Cápac turned his troops to the Pacific and headed south along the coast to the Gulf of Guayaquil before returning to Tomebamba in the Sierra where he succumbed to a disease (most likely smallpox) in 1534. It is believed that Pasto territory was under Incan rule for about ten years, probably from the period of 1525-1534. Nevertheless, the absence of social structures and the survival of the Pasto language through the arrival of the Spanish suggests that Incan cultural and political domination only reached initial stages. The chief motivation of incursions appears to have been control over the coca and salt production of the Chota Valley. Populations of Pastos (*mitimae*) were taken to the Lake Titicaca region of the Southern Andes, but there is no evidence of forced labour parties that were brought to the Pasto region of the North.

Evidence of effects of the Spanish conquest in the sixteenth century and early processes of colonization on indigenous populations in the Northern Andes is scarcely documented. Diverse authors show that depopulation was a major feature of the period. Between 1525 and 1595, the population of the savannah of Bogotá (excluding the city of Bogotá), north of the Pasto Territory, decreased was from 140,000 people to 62,791 (a decline of about 2.2:1) (Villamarin and Villamarin 1975). In the Central Andes, south of the Pasto area, the population declined from about 4,641,200 to 1,349,190, a proportion of 3.4:1 (Smith, 1970 and Cook, 1981). Larrain (1980) estimates that when the Spanish arrived in the Pasto territory in 1534, the population of the area was about 240,000, spread among 25 major settlements. By the end of the sixteenth century, that population was less than 60,000, a proportion of 4.0:1. In terms of depopulation, the Pasto Territory may have been the most affected region of the Andes. According to Larrain, the primary causes were two fold: wars with conquistadors and forced extraction of populations as labourers and slaves to faraway lands.

Spanish settlement and the *encomienda*

> The indigenous diaspora [in Carchi] created conditions for an easy amalgamation between indigenous and whites that would open the way for a *mestizo* amenable to the cultural whims of the colonists. – Miño (1985: 99)

Following the death of Huayna Cápac, the death of his son Huascar to Atahualpa in the Incan Battle of Cuzco, and the capture and execution of Atahualpa in Cajamarca in 1533, the Spanish had effectively conquered the Incan Empire that spanned from northern Chile through southernmost Colombia. The Spanish Crown increasingly claimed ownership of all natural resources and people in the region, and initially it distributed governance rights to conquistadors. The early colonization process in the Americas centred on the assignation of land concessions and the native people who lived on it, a policy known as the *encomienda* (Newson, 1992). The majority of conquistadores and colonists wanted to acquire wealth and return to Spain with improved finances and higher social status. While the concessions in the Northern Andes were large, the difficult climactic conditions and relatively low value of highland crops at the time made agriculture a difficult means of fast wealth. Furthermore, agriculture required investments in time and resources that were beyond the immediate plans of the visitors. In the sixteenth century, the chief means of wealth were slaves and minerals, especially gold and silver. The population of Carchi was relatively small and distant from the Caribbean, Central American, and South American trade centres. No gold or silver deposits were found in Northern Ecuador, so the area largely was overlooked. Meanwhile, the discovery of deposits in Peru and Bolivia led to tremendous mineral exploitation activity that would carry on for centuries. It was not until the value of slaves and minerals dropped at the end of the sixteenth century, that the Spanish began to show interest in agriculture as a means of accumulation.

The *enconmienda* policy was first implemented during the re-conquest of Spain against the Mores. Its introduction to the Americas was modified to avoid problems that were found on the Iberian Peninsula, particularly with regard to land titling. As a result, the policy applied in the Americas no longer included absolute entitlement to land (Chamberlain 1936; Newson, 1992). As practiced in the Andes, the *encomienda* involved the award of a number of native peoples to an individual in exchange for their protection and conversion to Catholicism. In return, the *encomendado* could charge tribute and demand labour services of subjects. Initially, territorial governors had the authority to assign *encomiendas* with the approval of the Crown. Following the New Laws of 1542, entitlements were conferred to the local governing unit of royal subjects, known as the *Real Audiencia*. In the case of Northern Ecuador, the *Real Audiencia de Quito* exercised this authority.

The first *encomiendas* were awarded for life to outstanding conquistadors. Thereafter, the governing officials tended to award them to family and friends. Colonists complained to the Spanish Crown that they were not included in awards, and as a result, the New Laws of 1542 excluded church and government officials from receiving *encomiendas*. Entitlements were highly unstable due to endless concessions, annulations, confiscations, and reassignments. The Crown was hesitant to relinquish control over land, but due to pressure from the new landholders in the Americas, it eventually agreed that concessions could be passed down for two generations. The New Laws also gave the Crown the right to recover expired *encomiendas* and to terminate future awards.

Due to the progressive decline of indigenous populations throughout the Americas, the Church pressured the Crown to adopt more humane laws. Furthermore, following initial mineral exploitation and the transition to agrarian economies, a labour shortage became a concern. As part of the New Laws, the Crown began to make provisions for the abolishment of slavery and distribution of limited land entitlements to indigenous people for subsistence agriculture. In practice, conquistadors distributed land first, and then local rulers or *cabildos* distributed the remainder among the indigenous. Nevertheless, Newson (1992) raises doubts over whether the laws were obeyed. The *encomienda* and the practice of forced personal services continued, if informally, until their abolition in 1812.

Newson (1992) explains that the *repartimiento* was a series of laws that attempted to create more flexible labour markets. In part, this legislation was demanded by those who did not benefit from the *encomienda* but who had labour needs. The policy involved forced labour that was paid a fixed price upon completion of a contract. By design, the *encomendado* or the Crown could not oblige participants to pay tribute. The employer agreed to provide a stipulated financial compensation, adequate food, and guarantee humane work conditions and treatment of subjects. Commonly, the contract lasted two or three weeks. The law stipulated that labourers could not be employed at great distances from their communities (maximum of ten leagues) and that indigenous could not do certain dangerous jobs (such as mining, a provision that was later lifted due to labour shortages). The *Real Audienca* governed over these contracts, with an assigned judge deciding upon the distribution of the indigenous labour force. Once the stipulated period of work was completed, subjects were free to return to their community and were replaced by a new group of labourers, usually from the same community. In practice, employers violated many of these stipulations. For example, payment was often in-kind and food and living conditions were inadequate. Further, assigned tasks commonly were impossible to complete, which was used to justify incomplete compensation.

In addition to the alteration of indigenous economies due to depopulation and the redistribution of land, Newson (1992) found that the arrival of the Spanish affected patterns of survival in other ways. For example, land concessions excluded indigenous people from farming and hunting activities. Forced labour and tribute payments reduced time available for independent productive activities. While falling populations decreased food demand, they weakened social organizations and disassembled collective labour needed for critical moments during the cropping cycle, such as land preparation and harvest. Labour demands forced people to abandon their communities for extensive periods of time, leading to crop failures and seed losses. The imposition of new crops further interrupted seed availability and disrupted traditional markets. A large portion of harvests was paid as tribute. For example, maize farmers commonly handed over between 25 to 50 percent of their harvest to *encomendados* or local governors. Indigenous people also had to pay for increasing costs of the Church associated with building structures, paying clerics, and conducting religious ceremonies.

The Spanish saw that once native *caciques* accepted external authority and converted to Catholicism, the rest of the community followed. As a result, the cooption of local leaders became a political strategy throughout the Americas. *Caciques* were given privileges, such as exemption from tribute payments and routine labour. They sometimes were allowed to carry arms, mount horses, and own slaves. Their offspring gained access to Spanish schools. In this way, they became political intermediaries between the *encomendados* or colonial authorities and the commoners.

The Spanish made strategic efforts to destroy the religious symbols of indigenous populations. They built churches on top of temples and replaced idols with symbols of the crucifix and the Virgin Mary. Family structures were decimated through death during conquest battles, forced labour and migration of members, disease, and starvation. Furthermore, many officials, priests, and *encomenderos* had forced sexual relations with indigenous women and appropriated them for personal services, such as domestic labour. This led to a large number of orphans (Benzoni, 1967).

While miscegenation occurred during the sixteenth century, its contribution to indigenous depopulation was only significant in later generations. Newsome (1992) explains that miscegenation was a function of the degree of interaction with other races and was encouraged by male dominance in European and African cultures. It was most common in communities where indigenous were forced to work as domestic servants for whites, such as in mining towns and under the hacienda system of agricultural development, where men of mixed blood were hired as administrators over local indigenous populations. Knapp (1991) compared the 1780 and 1950 censuses and found that the national population increased from 412,000 to 3,154,000, an annual growth rate of 1.20 percent. The highlands grew more slowly than the lowlands, with only Carchi and the southernmost provinces of Loja and Azuay growing at comparable rates. During the same period, the indigenous populations, i.e., those classified as indigenous under the colonial tribute system, grew from 265,000 to 444,000 people, an annual rate of 0.30 percent. According to Knapp, this rate was not due to emigration or mortality, but rather acculturation – i.e., the process of miscegenation to mixed ladino (Spanish-indigenous) culture. Rates of acculturation in the highlands generally were less than one percent. In contrast, that of Carchi was over two percent.

While the colonists depended on local crops for sustenance, they began to introduce higher value cash crops, such as sugarcane, tobacco, and wheat (*Triticum aestivum*) for export to Europe. It has been estimated that in the seventeenth century, one ton of sugar cost the lives of two slaves (Hobhouse, 1987). By 1700, the ratio had dropped to one ton of sugar equalling one life. By the end of the eighteenth century, two tons of sugar cost one life. Hobhouse estimates that between 1690 and 1790, Europe imported 12 million tons of sugar, at a total cost of about 12 million lives. Sugarcane was introduced to the Chota Valley at the beginning of the seventeenth century and became the major export crop. Wheat and barley were grown at median altitudes. Cattle were introduced to lower elevations of the coast, where grass was too tall for sheep. Cattle, horses, and sheep were introduced to the *Páramo* Andes of Venezuela, Colombia, and Northern Ecuador (Monasterio, 1980; Llano, 1990).

Spanish activities affected indigenous communities through demands on land, labour, and production. While mines and forced migration led to depopulation, locally the Spanish began to place greater pressure on land access as well as available labour to work on expanding agricultural enterprises. While tribute payments contributed to poverty, other non-official obligations, such as forced purchases, increased this burden. The heightened demands on production and labour combined with decreased access to natural resources reduced the viability of native communities, obligating people to look for salaried employment. In the new social and economic environment, the indigenous communities generally lost access to natural resources and their racial and cultural identity began to steadily decline.

Hacienda system

> The *hacendado* generally is humane and compassionate, he exercises over his workers a paternal authority that, distant from carrying the rigours of slavery, can be considered as beneficent tutelage for a race that little by little is entering the road to a civilized life. – Luis Felipe Borja, documented in *Huasipungo*, by Jorge Icaza, 1934.
>
> Of all the Spanish activities, agriculture was what had perhaps the greatest impact over the lives of the indigenous. – Linda Newsome, *The Cost of the Conquest* (1992: 201)

According to Guerrero (1975), the hacienda system was the result of three interconnected events: the expropriation of community land by conquistadors and the Crown during the 17th and 18th centuries, retention of populations on hacienda land, and continued subjection of farmers to the payment of tribute from *caciques* to the crown and finally to the hacienda. By the end of the seventeenth century, agriculture became the source of economic development in Ecuador and the hacienda system the principle means of agricultural production. As a consequence, Ecuadorian society came to revolve around the hacienda.

Remaining vestiges of pre-Colombian Andean cultures, particularly traditional social structure and "ecological verticality," would end with the hacienda period. The hacienda system evolved in response to growing domestic and regional markets as well as the distant markets of Spain, as with the case of wheat and sugar. The type of agriculture and its demands on indigenous land and labour depended on the local environment and the productivity of land. Diverse researchers have argued that the Spanish were interested in agriculture due to the high cost of living and the absence of opportunities to earn money in cities and towns (Newson, 1992; Borah, 1951). Sometimes, it was in search of mere self-sufficiency, particularly in response to declining indigenous populations and food productivity. In the seventeenth century this occurred as a result of an economic depression in the Americas associated with the decline of the mining industry and trade with Spain. The exhaustion of mines and ensuing food demands in Europe resulted in the expansion of area under cultivation in the Americas and demands for labour, heightening pressures on native peoples.

A requisite for agricultural production was land, which could be obtained in diverse ways. The most common, particularly following the conquest, was to forcibly capture land from native populations. Secondly, Spaniards could purchase land from a community and present a request on their behalf for legalized ownership. Indigenous people often did this to *encomiendos* as a means of liberating themselves from tribute debt. Prospective landowners also could declare an area abandoned and request a concession. With the decrease in indigenous populations, it became increasingly difficult to maintain land in cultivation. As such, fallowed land was prone to concessions. Officially, communities were to be consulted, but in practice concessions commonly occurred in silence. In 1591, the Crown ordered that all land obtained illegally be returned to the Crown, but at the same time, it declared that all illegal land could be legalized through the payment of a commission. In practice, this policy formalized the illegal purchase of land, and it raised money for the Crown. Further, cattle or sheep ranching on underutilized land was a favourite tactic of Spanish settlers for obtaining access and control over new territory. With the economic growth brought on by the conquest of the Americas, such processes accelerated during the seventeenth century. As miscegenated populations increased, they began to enter into conflict with native-borne Spaniards over land use and ownership.

In the eighteenth century, the Spanish Crown took measures to support agricultural development and promote exportation of essential food and cash crops to Europe. This included exclusions from taxes and quotas for priority crops, such as indigo dyes, cotton, cacao, sugar, and coffee. Import taxes on processing equipment for sugar and coffee were abolished. Sheep and cattle production were advantageous due to their low labour costs and the ability to exploit natural grasses. Nevertheless, a poor transportation system and isolation made export of animal products impractical and limited to a secondary enterprise. The European textile crisis at the beginning of the eighteenth century caused a crash in sheep production in Ecuador, which led haciendas throughout the country to shift production towards extensive grain production for export, especially wheat, barley, and maize. The extensive nature of grain production increased the demand for labour, which was compensated for by "passing rights" (i.e., permission to cross through hacienda territory) as well as by access to land, water, and firewood. By the beginning of the twentieth century, the haciendas of Ecuador eventually produced over 80 commodities for export (Hurtado, 1977).

The hacienda would come to mean individual ownership of land on which resided a stable servant population, whose labour was exchanged for in-kind payment, often through land rent. There was a direct relationship between the landowner (in Spanish, the *patrón*) and the hacienda. The *patrón*'s personality often shaped the nature of the hacienda as a social and productive enterprise. Land was cultivated with limited technology and a limited portion of capital generated from production was reinvested in the enterprise, with the rest consumed by the landholder and his family. Generally, *the patrón* extracted surpluses for personal profit or investment in emerging business opportunities elsewhere, such as industry, finance, and urban speculation. The hacienda became the dominant form of social organization in rural areas under what became known as the "*minifundio-latifundio*" model (Tannebaum, 1965; Barahona, 1970; Guerrero, 1975).

A stable labour force lived on the property as *wasipungeros*,[3] complemented by a paid part-time work force during periods of high labour demand, such as at planting and harvest. Payment continued to be in-kind through passing rights, access to land, water, and wood in the case of *wasipungeros* as well as a portion of the harvest in the case of part-time labourers. Landowners provided primary-level formal education as well as religious indoctrination. Generally, labour was not indebted to the landowner, but workers preferred to stay on the hacienda due to the absence of opportunities elsewhere. Labour was collective and distributed by simple, non-technical tasks. Men worked in the fields. A small number of women worked as domestic servants. Kids usually did menial jobs around the house, but also contributed to planting and herding animals. The *hacendado* commonly resided at the property or lived in a nearby city and delegated administration of the productive enterprise to a *mayordomo* who supervised labour and coordinated on-farm activities.

Due to the relatively large labour force (in comparison with earlier periods), technological development was not a priority. Technology was limited to animal drawn traction, hand implements, such as shovels and hoes, and local varieties. An increasing proportion of farmland was dedicated to pasture for animals, especially cattle for dairy and meat. The majority of crops was sold domestically and met domestic consumption and extractive needs.

The system of *wasipungo* land rent to large landholders continued through the independence movements and the creation of the Republic of Ecuador in 1830. In 1831, the first President, Juan José Flores, created the Ministry of Hacienda and passed a law formalizing the "*sistema de concertaje,*" which, similar to the *wasipungo*, tied indigenous labour to the haciendas through debt and jail sentences. In practice, this indefinitely perpetuated the *encomienda* system. The legislature produced diverse laws to establish indigenous rights, especially a law in 1865 that would award indigenous communes collective usufruct rights

[3] *Wasipungero* is the Kichwa term generally used to refer to the indentured servants of the hacienda system. In exchange for labour, the *wasipungero* commonly was provided a small plot of land and resided in a settlement known as the *wasipungo.*

to land. In practice, however, the system of *concertaje* remained unaltered (Jaramillo-Alvarado, 1983). At the beginning of the twentieth century, the hacienda conserved many of its traditional qualities. In 1913, the Archbishop of Quito, Monsignor Polit wrote, "The *concertaje* exists always with the character of a sentence of life in prison in the *latifundios* and when a peasant resists its servitude, be it in the city or in the towns, the official complicity leaves open the jail for entombing the Indian" (Saénz, 1933: 107, cited in Barksy, 1988).

According to Jaramillo-Alvarado (1983), the liberal revolution of 1895 and ensuing political movements to abolish the *concertaje* system gained force into the twentieth century. Following the American emancipation of slaves in the mid-1860s and the Mexican Revolution that began in 1910, public opinion in Ecuador began to shift against the exploitation of native peoples. Despite strong opposition by large landowners, in 1918, the liberal President, Alfredo Baquerizo Moreno, passed a law through Congress abolishing the *concertaje* system.

Growth of towns and cities in Europe as well as Colombia and Ecuador during the period between 1880 and 1930 created new demands for agricultural goods. Haciendas in Carchi showed a marked expansion in export activity to Europe – especially cattle hides and grains – as well as diversified production for local markets, including wood, wheat, barley, potato, animals (sheep, cattle, and horses) and lesser products to Colombia. According to Orellana (1928; cited in Barsky, 1984: 50), in 1926, the province's exports exceeded its imports by a factor of 70 (Sucre 1,801,418 for exports versus Sucre 26,017 for imports). The hacienda increasingly became a commercial enterprise, producing new tendencies towards production intensification and profit maximization. Over time, this would change the management of capital and technology, as well as the relationship between landowner and labour.

Market-oriented haciendas invested in machinery (primarily tractors and ploughs) and later, agrochemical inputs (first synthetic fertilizers, followed by pesticides) and improved plant varieties. Additionally, they began to transition towards specialised salaried labour. "One good paid worker could do the job of five *wasipungeros* in *minga*."[4] The global financial crisis of 1929 and ensuing events left these haciendas heavily indebted to creditors. In the 1930s and 1940s Ecuadorian companies, especially from the beer industry, protested against the export of wheat and barley to their competitors in Colombia, leading to a government policy prohibiting the export of these products and contraband. The devaluation of the Colombian peso in the 1950s combined with Ecuadorian subsidies for commodity imports severely hurt grain producers. As a result, many haciendas went into economic decline during this period, forcing *hacendados* to seek financial opportunities elsewhere and become absentee landlords. In the North, many haciendas began to abandon intensive production for export and to concentrate on the more simplified potato-pasture system that dominates the Carchi landscape today.

Given the financial difficulties of agriculture, many *hacendados* turned to business and industry for wealth. Their families moved to the city. While the *hacendado* commonly travelled to the hacienda to supervise activity, his wife and children generally stayed in the

[4] Conversation with Juan Carlos y Diego Landázuri, 10 December 2003.

city. During this period, on-farm investments were limited, while off-farm investments made many *hacendados* wealthy. In some cases, the traditional *hacendado* altogether lost interest in agriculture as a business, and investors arrived to purchase properties. Many absentee and ex-*hacendados* became business and political leaders, forming a powerful elite throughout Ecuador (Tannebaum, 1965).

During the second half of the twentieth century, haciendas diverged between two principal economic survival strategies: 1) the traditional, labour-intensive and low profit enterprise that conserved social characteristics of the past, and 2) a new, more intensified form of the hacienda as a moneymaking enterprise. This latter strategy involved mechanization of tillage, the introduction of new varieties and agrochemicals, improved pastures, and infrastructure improvements, introducing more production oriented management. These enterprises tended to increase the capitalisation of the hacienda, turning it into an agribusiness. New administrative mechanisms were apparent in the technical training of *mayordomos*, the increased attention paid to bookkeeping, and the expansion of area under production. They strategically made permanent capital investments that replaced variable capital – e.g., the *wasipungeros* and other forms of informal labour. The hacienda as an agribusiness increasingly replaced in-kind payments with labour for salaries, which permitted greater control and demand over activities. Labourers began to work fixed hours from Monday through Saturday.

By 1950, population growth in the *wasipungo* sector as well as in the outskirts of towns led to a growing labour force and unemployment. Youths born on the *wasipungo* began to feel that land and natural resources belonged to them. These tendencies produced growing social malcontent. Meanwhile, market integration led to a situation where it was increasingly less convenient for *hacendados* to share products with *wasipungos*. In Carchi as well as in Pichincha, changing economies towards milk production, requiring about one-tenth the labour of agriculture, aggravated the labour crisis. As a result, it was increasingly convenient to find ways of breaking ties with the *wasipungos*. This created a class of unemployed and landless former *wasipungeros* and the need to attend to their concerns.

Urban growth, the collapse of the cacao industry, and low food production affected foreign exchange earnings and created domestic food shortages. As a consequence, governments throughout Latin America began to develop policies centring on two interactive agricultural development strategies: resolution of the agrarian situation, especially inequitable land distribution, and improved production through technology development. It became important for *hacendados* to resolve matters in the face of growing organizational strength of peasant movements that were beginning to endanger the interests of large landholders, particularly their control over large tracts of land and natural resources. As a consequence, during the 1950s Ecuador saw numerous cases of voluntary handover of marginal land from both private and public haciendas.

Barsky (1978) and Barsky and Cosse (1981) described a great deal of social differentiation between the wealthy rural elite in Northern Ecuador. Tensions emerged between traditional *hacendados* and a newer class of market-oriented landholders that emerged with the growth of the "technification" and commercial development of the dairy industry.

Based on historical factors of establishment and development, farmer access to resources, and retribution systems, Barahona (1970) identified two basic types of haciendas during this period: 1) the traditional hacienda in disintegration – either through absentee landlordism or public haciendas under social conflict with farmers, and 2) the modern hacienda – either in process of diversifying production and formalizing employment arrangements or an emergent industrial era hacienda fully capitalized and organized under business principles.

As a result of his study on the diverse political responses of the large landowners (or *terratenientes* as they are called in Spanish) to agrarian reform, Barsky (1988: 390) concluded:

> The original sin [of the *terratenientes*], the *wasipungo* system and other forms of subjection of labour, whose social consequences have been the backwardness and misery of vast sectors of rural society, and at the same time the accumulation of wealth of the *hacendados*, is present. That which for many years had been seen with indifference by a good part of society, today is the target of open criticism by influential communication media that collects a growing national sentiment as well as the currents of reform pushed from the United States.

By the mid-1950s most large landholders came to view agrarian reform as inevitable and were obliged to adopt strategies of transition towards eliminating a *precarista* class. The *precaristas* were from the informal labour sector, commonly made up of landless labourers who were paid in specie and were outside the modern currency economy. The large landholders commonly faced two options: sell their land at strong market value or fight to save the farm. In Ecuador, this second strategy did not involve confronting social groups, but rather, the full subjection of their haciendas and themselves to processes of "modernisation." Meanwhile, competing *hacendado* interests prepared for a prolonged public debate over agrarian reform.

Agrarian reform

The proposals to end the hacienda system differed considerably across Latin America. In Peru, policies emphasized breaking up the monopoly of landholdings. Elsewhere, policies centred on opening up new territory for agricultural colonisation. Agrarian reform policies generally were aimed at transforming the *latifundio* system into multiple, independent agri-businesses employing new relations of production, modern technologies, and forms of market integration. The outcomes varied according to the unique political environment of each setting. In Mexico and Bolivia, for example, large landholders commonly kept control over the most fertile valleys and relegated the different forms of ex-*wasipungeros* and *campesinos* to less fertile, surrounding mountainsides. The process in Ecuador shared this quality to a degree, but it was influenced by the country's unique political context.

In Ecuador, a series of laws that appeared during the mid-1930s on communes, communities, and cooperatives (*Ley de Organización y Régimen de las Comunidades* and *Estatuto Jurídico de la Comunidades Campesinas in 1937*) and the Worker's Code[5] marked a shift in

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[5] *Código de Trabajo*, 1938

agrarian policy in favour of fundamental social reform (Costales and Costales, 1971; Hurtado, 1977; and Barsky, 1988). Following decades of growing national and international pressure to address the "indigenous problem," in part in response to the success of the Cuban peasantry revolution of 1959, on 31 January 1960, President Velasco Ibarra issued an Executive Decree creating the National Commission on Agrarian Reform, charged with leading public debates and policy formulation.

Barsky (1980) identified two obstacles of the policy negotiation process in Ecuador: the notorious fragmentation of indigenous and *campesino* movements, particularly those from private haciendas, and the weak, newly emerging urban-based industrial class with its own unique concerns and priorities. While hacienda owners increasingly appreciated the need to handover areas of land, they also sought to eliminate access to land, pastures, water, and fuel wood. Four competing factions emerged among the large landholders (Barsky 1980: 140-141):

1. Industrialised and capital-intensive agriculture sector: This grouping was composed of large landholders who had "modernised" – i.e., intensified production through large investments in technology, such as mechanization of tillage and milking, as well as the drainage and irrigation systems used in dairy farming. Galo Plaza was the leader of this group. He sought to end the precarious *wasipungo* system that threatened lesser capital-intensive haciendas. He promoted agrarian colonization of unused land, particularly in the Amazon basin, and industrialization as a means to employment.
2. Moderately intensified agriculture sector: This sector was composed of large landholders who had made fewer capital investments. Farm improvements were achieved through less expensive technologies, such as genetic improvement of herds, improved pasture management, and a lesser degree of mechanization. This group represented the more feasible model of development for most large landholders as it did not require a continual flow of capital. Prior to the agrarian reform law, many of this group already had begun voluntary transfer of land to *wasipungeros*.
3. Vulnerable large landholders: This group was made up of diverse actors, most of who controlled large, but resource limited tracts of land. Other members were from the second grouping, but who had rejected agrarian reform. This faction was generally represented by the Agricultural Bureau and was led by its President Marco Tulio González. Due to limited resources of these enterprises, large landholdings were essential for maintaining profit margins. While they generally accepted the need for formalizing labour relationships, they were less willing to give up land.
4. Resistant landholders: A fourth sector was composed of landholders whose productive strategy was dependent on cheap labour and dominant control over the *wasipungeros*. This group opposed any policy that would decrease landholdings or formalize labour relationships. Members were from haciendas in the South of the country. Haciendas from the Centre and North generally had accepted the need for fundamental agrarian change and generally did not belong to this group.

The text of Costales and Costales (1971) provides a detailed account of ensuing deliberations and political confrontations that transpired during the years prior to agrarian reform. The authors argue it was not a single modernizing sector or an external technocratic intervention enabled by a dictatorship and its military that made possible agrarian reform in Ecuador. Rather, it was the result of a confluence of interests, including those of the Catholic leadership, urban-based landholders, as well as agribusiness sectors. Diverse church and government bureaucrats, particularly from the National Geological and Anthropological Institute, fulfilled important mediation roles and brought about the consolidation of an imperfect policy that attempted to accommodate highly irreconcilable interests.

At a decisive moment, Pope John XXIII challenged the Catholic Church in Ecuador to take a stronger stance in favour of agrarian reform. In a 1963 letter to the government and people of Ecuador,[6] the Church called for "the promulgation of a law of agrarian reform, that will provide the bases for an adequate solution," and conciliation of the competing factions of its diverse constituency – military, *terratenientes*, *campesinos*, and the broader public, all of which shared a single religion. The Pope argued, "It is our fervent desire that this Catholic nation lives its faith in the practice of justice," and "The Church has become *proletarizado*," allegedly so should the rest of Ecuador. Growing public opinion and political parties organized around this opinion, and eventually, the resistant *terratenientes* came to the conclusion that agrarian reform was inevitable. The political stage was set for change. On 22 September 1964, the military dictatorship issued Supreme Decree No. 1480 stating:[7]

> The Government of Ecuador, with the expedition of the present Law of Agrarian Reform and Colonisation indicates a change of historic transition in the economic and social structure of Ecuador. Given the importance of agriculture for the economy and life of the entire Ecuadorian society, the vices of agrarian structure have become reflected in the social institutions of the country, in which they have promoted less just treatment in the relations between the men that take part in the process of agricultural production. The modifications established the legal bases of said structure. Thus, began the Agrarian Reform, and the Government placed the first stone for building a more harmonious, just, and dynamic Ecuador.

A multifaceted piece of legislation that reflected the social complexities of the time, in practice, the Law of Agrarian Reform and Colonization pursued three central objectives: 1) the abolishment of *precarista* or "pre-capitalistic" forms of labour and creation of a new working class or proletariat; 2) "national integration" through allowing peasant farmers, especially ex-*wasipungeros*, access to land, credit, education, and technology, and 3) greater agricultural production through market integration and agricultural intensification.

The implementation of the policy was highly controversial and contested. The *Instituto Ecuatoriano de Reforma Agraria y Colonización* (IERAC), the agency charged with administration, faced tremendous challenges from the resistant *terratenientes* as well as from

[6] "*Carta Pastoral del Episcopado Ecuatoriano* to the people of Ecuador over the agrarian problem," 23 April 1963.
[7] The decree later would be published in the Congressional Registry No 297 on 23 July 1964.

farmer groups that usually were not very united. According to Cosse (1980: 414), "… the traditional sector of the *terratenientes* had done everything possible to first block, then slow, and finally, eliminate the agrarian policy of the military government, first in 1963-1966 and later in 1972-75 in alliance with fractions from other dominant classes." By no means was land distribution in Ecuador fully implemented.

By the end of agrarian reform in 1979, the Ministry of Agriculture concluded that IERAC managed to distribute just 33 percent of the territory slated for redistribution, reaching just 29 percent of intended rural beneficiaries.[8] Even when farmers acquired land, other challenges prevented them from improving their well-being. According to Costales and Costales (1971: 129), "Today the *wasipungero*, in many haciendas, is exposed to conditions worse than before. In many cases, the provision of land to the *wasipungos* became a negative." Resentful as a result of being the target of public hostilities, many previously sympathetic *hacendados* began to deny *campesinos* access to other resources needed for production, such as seeds, water, and tools. Chiriboga (1982: 104) concluded, "Agrarian reform [in Ecuador] has just produced a light expansion in the number of properties. The reasons for the increase in *minifundios* lie in the weak application of the Agrarian Reform Law, which as implemented, impeded access to land and productive resources for the great majority of *campesino* families." In contrast to the results elsewhere, agrarian reform in Carchi largely met the policy's objectives.

Abolishment of the *precaristas*[9]

With three articles, the Law abolished the *precaristas*:[10]

> Article 51. The *precarista* is understood as the *campesino* who works for his own benefit on land owned by others and who pays for its use in money, products, work, or other services.
> Article 52. Informal exploitations are prohibited.
> Article 117. The retribution for agricultural work will be made in cash currency. It is prohibited to pay in kind and to provide labourers, as total or partial payment for its work, access rights to land or the use of water.

While in practice it would prove difficult to implement, the legal precedent for liberating the *wasipungeros* and their communities was unmistakably established. Barsky (1988) explains that Carchi experienced uncommon patterns of cooperation with agrarian reform. The North was the region with greatest communication infrastructure and market access for milk and beef cattle production, where labour easily could be replaced by machinery or temporary work. As a result, the demands for labour were not as great as in other parts of the country. According to de Janvry and Glikman (1991: 120):

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[8] "Evaluación de la Reforma Agraria: conclusions y recomendaciones." Ministerio de Agricultura y Ganaderia, Quito, Ecuador. Cited in C. Verduga (1980: 452).
[9] "Precarista" or informal labourer; also known as an indentured servant or slave. In Ecuador, it took diverse forms, including the *wasipungero*, the *yanapero*, and *arrimaje* (see annex for definitions).
[10] Law of Agrarian Reform and Colonisation, 1964

> Agricultural activities in the Sierra have demonstrated a particular incapacity of retaining a labour force principally as a result of modernisation and the growth of cattle and milk farming. The production of milk in the Sierra has displaced with pastures an important part of the production of wheat, potato, maize, and barley, as a result aggravating problems of unemployment.

By holding on to choice fertile valleys, *terratenientes* in Carchi were able to meet their pasture needs, while selling the more difficult and less fertile hillsides to *campesino* groups, which provided additional currency to finance additional capital investments. Further, milk and dairy production for the cities provided a cash flow uncommon to haciendas elsewhere. Land transfer combined with a shift towards regular cash payment for labour allowed *terratenientes* to free themselves of social problems that had become associated with having *wasipungos* on their property and providing them access to their natural resources.

Miño (1985: 20) pointed out that one of the particularities of agrarian reform in Carchi was, "… the regional *terrateniente*, as a consequence of the popular land occupation movements, tended to move to other provinces, and as a result the regional control of *terratenientes* disappeared from the rural scene.... Agrarian reform produced a des-articulation of a previous dominant player in the society." For the ex-*wasipungeros* and other *campesino* groups, the relative absence of *terratenientes* represented a unique opportunity for their future involvement in Carchi society.

<u>Land redistribution</u>

A separate article addressed land redistribution as well as access to productive resources, credit, education, and technology:

> <u>Article 1.</u> The Agrarian Reform constitutes a process of gradual change of the agrarian structure and its economic, cultural, social, and political aspects, through planned operations of *afectación* [see below for explanation] and redistribution of land, as well as credit resources, education, and technology, for advancing the following objectives: national integration, transformation of the life conditions of *campesinos*, redistribution of agricultural income, and organization of a new social system of market-oriented enterprises.

Agrarian reform did not represent a land give away. IERAC facilitated the sale of land to the *wasipungeros* and other emergent farmer groups. Land could be obtained through two chief means: *afectación* (essentially, public seizure) or colonisation. According to the Article 38, *afectación* was "the absolute or partial elimination of ownership rights over rural properties that do not fulfil their social function. *Afectación* aims to correct the defects of the current structure of land tenure and land use." Non-fulfilment of "social function" primarily referred to land that was idle or underutilised, as well as situations where landowners did not respect the Worker's Code. In the Sierra, only properties larger than 800 hectares were vulnerable. Colonisation chiefly took place in the lowlands of the Coast and especially the Amazon. It required relocation of families and entire communities. From the beginning, a goal was "to put to work land that was idle, abandoned, and land of the State," as a means of relieving the "overcrowded" Sierra and "to civilise" the wild Amazon, thereby bringing it into State patrimony.[11]

In practice, land redistribution to groups commonly meant sale of fragile highland areas of questionably productive potential, thereby handing the ex-*wasipungeros* debt as well as a legacy of poverty. Joined by independent farmers, they became a growing class of marginalized rural poor – the *minifundistas* or *campesinos*. As a result of its limited resource base, this growing sector was not well positioned to accumulate wealth through market integration. In contrast, land redistribution in Carchi handed an emergent class of *campesinos* far more favourable conditions.

Based on the census data of 1964 and 1974, IERAC handed over a total of 2,280,000 hectares of territory in Ecuador, about 500,000 hectares of which came from haciendas. In 1954 1,400 families (0.4% of all farms) owned farms larger than 500 hectares, which represented about 45 percent of all cultivated land in the country. Meanwhile, about 90 percent of farm families cultivated small farms (areas of less than 20 hectares). By 1974, the number of landholdings over 500 hectares had dropped to just over 100 families, with about 500,000 hectares being distributed in the favour of smaller holders. Jordan (1988) explains that this was not only the result of agrarian reform but also inter-family divisions through inheritance and sales.

The three northern provinces of Carchi, Pichincha, and Imbabura were the greatest beneficiaries of land reform. Carchi led the way, with 92 percent of *campesino* groups receiving about 41 percent of all arable land, followed by Pichincha (30% receiving 27% of land) and Imbabura (24% receiving 24%). Costales and Costales (1971) points out that the land handed over generally was of poor quality with limited or no access to water, except in the North where there was a greater abundance of fertile soils. Between 1964 and 1971, about 50 new farmer organizations were formed in Carchi for the purposes of land acquisition. Groups were made up of different kinds of farmers, including ex-*wasipungeros* and migrants from Colombia and elsewhere. Generally, *campesino* groups in the highlands were sold the least productive land at prices higher than market value (Costales and Costales, 1971:132). In Carchi, however, groups negotiated prices closer to market value. According to the 1956 census, 0.14 percent of all landholdings in Carchi controlled 63.1 percent of the provincial area, and 125 farms controlled 117,000 hectares, with the nine largest farms averaging 5,911 hectares each.[12] Barsky and Llovet (1982) assessed inequality of land acquisition through comparing Gini coefficients between 1954 and 1974.[13] While the average change throughout the Sierra was an improvement of -0.332, in Carchi the coefficient dropped the most of any other province, from 0.8612 in 1954 to 0.7860 in 1974 – a change of -0.752. Overall, 91 percent of land distributions in the Sierra ended up as properties between ten and 100 hectares in size (Table 3.2). In Carchi that figure was 56 percent. About 40 percent of all land distributions in the province were of

[11] Abel Gilbert, Vice-President of the Plaza Administration, upon proposing the National Institute for Agrarian Reform in 1959, in Costales and Costales (1974: 69).
[12] National Agriculture Census, 1954, cited in Barsky, 1984: 50.
[13] The Gini coefficient measures the inequality of income distribution within a country. It varies from zero, which indicates perfect equality, with every household earning exactly the same, to one, which implies absolute inequality, with a single household earning a country's entire income.

less than ten hectares. More than any other province of the highlands, agrarian reform converted landownership in Carchi from large holder to smallholder farms.

Table 3.2 Distribution of land (by number of parcels and area) in Carchi compared to the rest of the Ecuadorian highlands before and after agrarian reform (Barsky and Llovet, 1982)

	Change in number of parcels between 1954 and 1974 (%)		**Change in area of parcels between 1954 and 1974 (%)**	
Size (ha)	**Highland provinces**	**Carchi**	**Highland provinces**	**Carchi**
0.1-1	+35.5	+65.3	+22.7	+13.3
1-5	+7.7	+34.6	+4.9	+23.6
5-10	+29.5	+37.9	+26.2	+31.6
10-20	+72.8	+48.8	+69.8	+48.8
20-50	+88.4	+38.2	+91.9	+33.3
50-100	+67.3	+17.6	+68.2	+20.9
100-500	+23.9	+21.1	-7.1	+14.2
500-1,000	-5.4	-44.0	-9.9	-47.6
1,000-2,500	-19.9	-65.0	-17.0	-52.7
> 2,500	-37.7	-66.0	-46.6	-71.6

Market integration and agricultural intensification

Tied to land tenure was agricultural intensification. MAG and the *Banco de Fomento* provided loans in the form of seeds, fertilizers, and pesticides. To payoff debts, groups immediately had to produce for the market and earn currency. For most, it was the first time they had a direct relationship with commercial markets.

Potato quickly became the cash crop of Carchi. In 1974, it represented about 70 percent of the gross internal product of the province,[14] the vast majority of which was for export to Colombia and elsewhere in Ecuador. During this period, between 61 and 67 percent of farms became economically specialized in potato production. The mono-crop of potato created a new paid labour market in the province, often filled by a landless peasantry that lived on the margins of towns and had not benefited from agrarian reform.

The 1970s became a decade of oil exploitation in Ecuador that would become the central preoccupation of the government to this day. Oil financed the "professionalisation" of the military, national infrastructure (roads and electricity), as well as national debt. As a result, the agriculture sector became much less important as a growth strategy. Additionally, because the benefits of agriculture were widely distributed, it was far easier to concentrate the wealth from oil for both public and private purposes. A final surge in agrarian reform occurred during the first half of the 1970s, largely for the politically expedient purpose of quieting the rural masses. The farmer movements that had organized for land acquisition did not normally have the capacity to address the subsequent individual and collective needs of farmers – namely intensification of agriculture and the penetration of markets. As a result, many cooperatives disbanded and divided land that earlier had been won under agrarian reform.

[14] National Agriculture Census, 1974.

During this period, the remaining large landowners and private business interests – many of them former *hacendados* – organized a counter movement culminating in the 1979 Law of *Fomento y Desarrollo Agropecuaria*,[15] which created the legal framework for ending further land redistributions and criminalising informal farming as well as land invasions. With the arrival of this law, the period of agrarian reform ended. More than elsewhere, agrarian reform in Carchi effectively converted the large properties and reorganised agrarian society around commercial markets, leaving behind an unusually solid foundation for smallholder-based agricultural development.

Conclusions

> Who knows what genes supported what characteristics. The truth is that the strong mix of blood between natives and Spanish [in Carchi] seems to have been one of the most compatible in our country. As a result, the social structure of Carchi has been much less stratified and racist than in the rest of the country. – Mariana Landázuri C. (2003)

Many people of Carchi little understand its history. As Mariana Landázuri wrote, present-day Carchi is made up of relatively well-off smallholder, *mestizo* growers. The province does not suffer from racial tensions between native highland peoples and the "more civilized" Spanish-speaking populations. How did Carchi's apparent serenity come to be?

The agriculture of the highland Pasto culture of the Northern Andes evolved to exploit environmental niches distributed across ecological floors. Without idealising what traditional society may have been, this "micro-vertical" organisation led to relatively stable food production that supported substantial populations, roughly equivalent to that of modern time. The brief arrival of the Incas in the early 1500s and immediately followed by the Spanish sparked a violent uprooting of traditional society, a processes of socio-environmental dis-embedding that would carry on into the twenty-first century.

During the sixteenth and seventeenth centuries, the Spanish Crown, conquistadors, the Catholic Church, and other externally based regimes reorganized traditional society around distant interests. The Pasto resisted assimilation and may have been the last highland culture in Ecuador to loose its native language. Nevertheless, as a result of labour camps, forced migration, and to a lesser extent disease, the present-day region of Carchi was de-populated by about three-fourths. By the end of the seventeenth century, the Pasto language and remaining vestiges of its culture had been supplanted and disappeared.

Most conquistadores came to the Americas to extract wealth and return to their motherland with improved social standing. The most expedient way to achieve that was through minerals, and the Crown awarded highly regarded subjects control over silver and gold mines. The remainder were relegated to agriculture and were provided territory and control over its denizens under a policy called the *encomienda*. This arrangement eventually evolved into a feudal-like hacienda system, which in the eighteenth century, came to reign

[15] In this context, *fomento* means the promotion or intensification of agriculture, signifying both crops and animal production.

over the majority of the highlands. While some products were exported to Europe, originally the hacienda concentrated on local production.

Lacking mineral prospects, Carchi society became organized around agriculture, and its remaining population became indentured servants or *wasipungos* under a handful of large haciendas. With the decline of the mining industry and food shortages in Europe during the later half of the nineteenth century, the hacienda in Carchi increasingly became an export-oriented enterprise, thereby providing surpluses and wealth for the *hacendados*. This tendency continued over the ensuing 150 years, complemented by the growth of domestic markets in what became the Republics of Ecuador and neighbouring Colombia.

By the mid-twentieth century, growing public concern over the "indigenous problem," diversely understood as a human rights issue as well as the "impractically" of a mass population of destitute rural poor, followed by a series of international events, including the independence movements in Africa and the Cuban Revolution, shifted public opinion away from the hacienda system and towards social reform. Further, growing food demands in cities and a stagnant national economy created the conditions for the "capitalisation" of haciendas and more equitable land redistribution, which culminated in the 1964 Law of Agrarian Reform.

The social roots of present-day Carchi are largely hidden from view. With the decline of the hacienda system nearly five hundred years after the Spanish arrival, traditional Andean society underwent tremendous change. The system of vertical farming was supplanted by extensive, horizontally oriented agriculture vulnerable to the climatic extremes of highland mountain environments as well as pest and diseases. While overall agrarian reform was only partially implemented – by most estimates about 30 percent in terms of land redistribution to ex-*wasipungeros*, it effectively ended informal *precarista* labour. Agrarian reform in Carchi uniquely led to a fundamental redistribution of land towards an emergent class of smallholder farmers or *campesinos*. Chapter 4 examines the ensuing developments of agricultural modernisation in four communities.

Chapter 4

Agricultural Modernisation in Four Communities

Introduction

Growing protests over the exploitation of indigenous peoples during the twentieth century culminated in the 1964 Agrarian Reform Law. The ensuing period would usher in to rural life the agriculture expert, industrial era technology, and the commercial market. With its ample resources, communication infrastructure, *mestizo* population[1] as well as its access to markets in Ecuador and Colombia, at the beginning of the 1970s Carchi was particularly well poised for agricultural modernisation and development. Nevertheless, experience elsewhere would raise doubts over such optimism.

Based on research in the American Midwest, Cochrane (1958) coined the metaphor of the "agricultural treadmill" to describe the self-defeating process of innovation and debt associated with modern agriculture, especially when a large number of farmers produce the same undifferentiated commodity. Under such conditions, no individual can influence prices (i.e., farmers are "price takers"), so competitiveness depends on improved productivity through on-farm innovations that increase production per area or decrease costs. Cochrane found that when an individual farmer innovates, others quickly follow course and over time average productivity rises, production levels increase to the point where market supply becomes saturated, and commodity prices drop. Under such conditions, Cochrane argued, the "early adopters" gain a windfall profit, but later adopters are compelled by price squeeze to also follow suit. Thus diffusion becomes market propelled. Those who cannot keep up eventually drop out and their resources are taken up by the stayers. Ultimately, the agricultural treadmill leads to scale enlargement, as a relatively small number of individuals who have unique access to assets and capabilities for innovation squeeze out the less fortunate and efficient majority.

Leeuwis (2004: 41) explains why governments tend to favour the treadmill:

> While farmers are often unhappy about such a "rat-race," governments tend to like it because "treadmill" processes tend to be accompanied by: (a) lower prices of agricultural products for consumers; (b) increased competitiveness of agriculture in comparison with other countries; and (c) release of labour for non-agricultural work.

Meanwhile, agriculture support institutions built around external knowledge and technology, such as public extension agents, agrochemical dealers, credit banks, and

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[1] As summarised in Chapter 4, the depopulation of Carchi during the 16th and 17th Centuries followed by processes of re-population with mixed-raced Spanish speaking *mestizos* signified for some that the North no longer had to deal with the "indigenous problem" of the Southern highlands.

marketing structures, emerge to feed and drive technology development (Röling and Jiggins, 1998). Over time, these actors organize into a politically influential network that promotes the sale of products and services, thereby becoming an indispensable complement to the treadmill.

The large number of relatively small family farms that emerged from agrarian reform in Carchi created the conditions that allowed treadmill processes to take place, while ensuing modernisation policies encouraged integration in commercial markets. Due to the environmental limitations of the highlands, farmers came to rely on a single commodity – potato. Supply provided by many smallholders meant that no individual could drive prices, so essentially, all potato farmers in Carchi received the same price for their harvest. As individual farmers adopted technologies to improve their efficiency of production and technologies diffused, *Carchense* farmers became increasingly exposed to price squeeze, scale enlargement, and external competition.

In light of the experience of four rural villages, this chapter pursues a single line of questioning: what influence did agricultural modernisation have on smallholder agriculture in Carchi, and how have developments affected rural people and their communities? I draw on multiple methods – farmer self-registries, national census data, semi-structured interviews, participant observation, situational analysis, and consultative workshops – to examine major developments and trends since agrarian reform at the four locations. To explore potential influences of expert knowledge and technologies in the macro-context of agricultural modernisation through treadmill processes, I concentrate on the evolving use of technology in potato production, especially the management of varieties, tillage, soil fertility, and pests associated with market integration. I go on to present how the communities summarised their history of social formations and transformations since agrarian reform, before making judgements on the outcomes of modernisation, in terms of agricultural sustainability and social consequences. I now begin with an introduction to the Ecuadorian rendition of agrarian reform and the arrival of technical assistance.

"Constructive justice" of agrarian reform

The agrarian reform process in Ecuador emerged as a result of what Barsky (1988: 390) described as the "original sins" of human exploitation and cruelty inherent to the *encomienda* and *concertaje* policies that were institutionalised through the hacienda system. The Law of Agrarian Reform of 1964 proposed to: "correct antiquated social relations" through "social justice," "equality of opportunities," "healthy living conditions," "production," "productivity," "adequate pay," and "integrated society." In practice, however, agrarian reform took on different meanings.

For the US government, agrarian reform became "land reform," a policy designed to quell increasingly hostile rural populations in Latin America. It was part of a geopolitical project to eliminate communism from the Western Hemisphere, as a result of growing social movements in Mexico, Guatemala, Cuba, Dominican Republic, Chile, Argentina, Uruguay, and elsewhere. Following the Cuban Revolution of 1959, the Kennedy Administration championed land reform in the region, and tied it to what became the "Alliance for

Progress" initiative.[2] Less publicly, the policy included clandestine support of tyrannous dictators and militaries throughout Latin America and assassinations of tens of thousands of students, politicians, and political leaders.[3] "Liquidation of the *precaristas*"[4] was a means of diffusing the rise of controlling "ultra-nationalism," the "virus of communism," and setting the groundwork for US-based regional security.

Unified around common concerns over urban growth, interests in inexpensive food for the cities, and agriculture as a means of capturing foreign currency, disparate parties in Ecuador found consensus around agrarian reform as a means of "economic development" and "modernisation." According to Costales and Costales (1971: 174), once the agenda of "liquidating the old *precarista* problem" for economic growth was agreed upon as the way forward, the problem became what to do with a massive population of ex-*wasipungeros*[5] who "did not have the most basic and rudimentary concept of land property rights" and who had "scarce or no preparation for receiving land." Further, it was argued, "In no case was there the social maturity or the previous preparation to constitute themselves as agents of change," so progress would depend on external intervention. The answers were built into the proposal for "agricultural modernisation."

Galo Plaza, owner of the large Zuleta hacienda in northern Ecuador and President of Ecuador between 1948 and 1952, became an outspoken proponent of the movement to modernise the haciendas and agriculture in general. Barsky (1988) explains how Plaza's proposals won public favour during the formulation of the agrarian reform policy and its early implementation. The analysis summarises what came to be the consensus on poverty and how it should be addressed (Box 4.1). For Galo Plaza, agrarian reform provided the means of eliminating "inefficient" haciendas that "perpetuated the *precaristas*." Rather than place the future of food production in the hands of the ex-*wasipungeros*, he argued for leaving the fertile highland valleys to the "modernised haciendas," what he described as "agribusinesses."

Citing the United Nations' Food and Agriculture Organization (FAO), the Inter-American Development Bank (IDB), and the US government, Plaza argued that it went without question that medium and large agribusinesses were the most capable of bringing knowledge and technology to bear on the pressing problem that he framed as "efficient food production." He contended that the ex-*wasipungeros* should be converted to a paid work force or proletariat to support agribusinesses as well as new urban-based industries in food processing, textiles, and small manufacturing sectors. Implicit in his message was that there was not enough room for smallholder farmers in the highly valuable fertile valleys of the highlands, so the activity of the ex-*wasipungeros* should be limited to subsistence farming

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[2] John F. Kennedy first publicly proposed the Alliance for Progress development program during a speech on 13 March 1961. On 15-17 August 1961 the US government led a call for "regional land reform" and "integration of rural people into modern society" at a meeting organized by the Inter-American Economic and Social Council of the Organization of American States, which subsequently would became known as the "Carta de Punta del Este," for the location of the meeting at Punto del Este, Uruguay.

[3] Noam Chomsky (1992) includes a critical analysis on US foreign policy in Latin America during this period.

[4] As explained in Chapter 3, *precaristas* were the 'precarious workers' or informal rural sector that lied outside of the market economy.

[5] As explained in Chapter 3, *wasipungeros* were indentured servants of the hacienda system.

of less productive areas or unused regions of the Amazon through processes of re-colonisation. Galo's son, Leonidas Plaza, was more explicit:[6]

> In synthesis, liberated agrarian property in our country should be: 1) land of the Indian in the high Sierra combined with individual plots of communal pasture land; 2) promotion of internal colonisation, [as response to the] traditional panacea for the problem of men without land and land without men; 3) free competition of different systems of medium and large agri-businesses – individual, cooperative, and collective; 4) punishment of the vestiges of the *latifundio*, [i.e.,] of the unproductive ownership of land by progressive imposition. Agrarian policy could not be more practical and just, a product based on *constructive justice*.

Closely tied with the agrarian reform policies, the Ecuadorian government adopted new language. For example, in the documents of the Ministry of Agriculture the *finca* or *granja* (farm) became the "*Unidad de Producción Agropecuaria*" (UPA) (literally, the Agricultural Production Unit), and the hacienda (plantation) became the "medium to large enterprise." The UPA was: "all the land that is dedicated, either partially or in entirety, to agriculture and animal production and that is worked, directed, or administered as a technical or economical unit, directly by a person (the producer) or with the help of other people, without consideration to ownership, legal condition, size, or location. The UPA can be composed of one of various lots or parcels of land."[7] The *campesino* or *hacendado* became the small or large holder "producer," signifying "the legal or natural person who had responsibility for managing the UPA, to which corresponds technical initiatives and that owns full economic responsibility of the said property or as shared with others (e.g., through sharecropping)." The government officially converted agrarian reform from a policy based on social to economic ideals. Land reform as a means to "empowerment" and "social justice" became a means to "rural development" in the name of "increased production," "efficiency," and "productivity."

Through consensus around urban-based priorities of ample, cheap food as well as geo-political interests of anti-communism, the "constructive justice" resolved the controversy over agrarian reform. *Hacendados* would come to own less land, but they strategically would hold on to the richest resource base of the valleys, forests, and water. That, combined with control over labour and markets, enabled them to conserve their economic capacity and social position. Many would get involved in industry, especially the agrochemical and food processing industry, and politics. As Ecuador shifted from military dictatorships to democracy, the earlier class of *hacendados* would become congressmen, ministers, and presidents. The new concern became implementation of the modernisation project.

Who would decide on matters of efficiency and productivity? How would new knowledge and technology arrive to agriculture? The answer became the nascent rural development industry led by a new class of agricultural experts made up of researchers, *técnicos,* and salesmen.

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[6] *El Comercio* newspaper, 17 September 1961, as quoted in Barsky (1988:94).
[7] 'Basic concepts and definitions', National Agriculture Census, 1974.

Box 4.1 A summary of Galo Plaza's proposal of land reform as agricultural modernisation (as described in Barsky, 1988: 90-94)

- Colonisation of barren or uncultivated lands – based on the implicit understanding that the highlands were not large enough to employ the existing rural population
- Colonisation of under-used or inefficiently exploited land – the traditional, inefficient hacienda will no longer continue
- Strengthening of efficient haciendas or agribusiness – increasing efficiency (usually, production by area) became a central focus of the government and an overriding justification for its policies.
- Land transfer to *wasipungos* – land reform must end "outdated" social relations and generate an agricultural working class available for the development of agribusinesses. While Plaza was committed to ending the *precaristas*, in practice, this meant closing the inefficient traditional haciendas that accumulated wealth through extracting rent for land and water access.
- Elimination of the *minifundio*[8] – Through processes of colonization in other regions outside the highlands and ending processes of subdivisions, the administration proposed that farmers who lived on land of limited size or questionable arability must migrate either to new areas of colonization (primarily the Amazon) or to urban areas.
- Development of urban-based industry – Foreseeing the growth of urban areas, the administration proposed urban development as a means of absorbing the displaced working class. Particularly, it proposed the growth of food processing, textile, and small manufacturing industries.

Arrival of technical assistance

Global tendencies

Similar to other parts of Latin America, during the mid-twentieth century, Ecuador was introduced to an emerging regime of thought around notions of poverty and development (Escobar, 1995; McMichael et al., 2000). The US land grant system beginning in the 1860s, the independence movement of India in the 1930s followed by ensuing de-colonization processes led by the League of Nations in Asia and Africa, the New Deal Policies in the United States during the 1940s, and post World War II reconstruction efforts in Europe and Japan opened the way for the role of outsiders, especially technical experts and "technology transfer," in "community development."

The advent of technical assistance in the Americas was closely tied with geopolitics. Just prior to World War II, the US became worried about Nazi infiltration of Argentina, Brazil, and Mexico, so it began to explore cooperative agriculture programs as a means to strengthening political ties with those countries (Flora and Flora, 1989). The US Department of Agriculture (USDA) established experiment stations throughout Latin America and Nelson Rockefeller supported professionals from the USDA and land grant colleges to conduct agricultural development work. In the 1940s Colombia requested US support to "relieve the general state of social and economic crisis in Colombian

[8] As explained in Chapter 3, a *minifundio* was a small landholding permitting a family-level subsistence economy.

agriculture" (Cronshaw, 1982: 99). A particular concern was the opposition of large landholders to its 1936 land reform policy and the absence of an agricultural middle class (Smith, 1947).

According to Ruttan (1989: 173), "Lagging agricultural development was interpreted primarily as the failure to make effective use of available technology." At the end of World War II, the United Nations created the Food and Agriculture Organization (FAO) for the purpose of becoming a "global ministry of food and agriculture." The FAO mandate included the provision of technical assistance to countries, support to education, the collection of statistics on land use and production, and the publication of technical materials. By 1950, the United Nations had established development programs in over 60 countries of Asia, Africa, and Latin America, as well as smaller initiatives that were supported by missionary organizations and private organizations such as the Ford, Kellogg, and Rockefeller Foundations. By the next decade, however, the emphasis on "technology transfer" shifted, as agricultural research became central to global agricultural development strategies.

In 1941, the Rockefeller Foundation had begun to support technology assistance and transfer programs in Mexico, based on the land grant extension model (Mosher, 1957). Eventually, this led to the experience with plant breeding in maize and wheat, leading to the creation of the International Rice Research Institute (IIRR) in the Philippines in 1960 and the International Center for the Improvement of Maize and Wheat (CIMMYT) in Mexico in 1966, the first two centres of what would become the Consultative Group of International Agriculture Research Centers or CGIAR (Ruttan, 1989). By 1980, 12 international agriculture research institutes would be created, including the Lima, Peru-based International Potato Center (CIP) in 1971. The global ministry of agriculture had been complemented by a global agriculture research service.

<u>Entry into Ecuador</u>

In 1956, the UN initiated the Andean Mission in Ecuador – the first international development project of its kind in the country (Barsky, 1988). It proposed infrastructure development and "*campesino* integration" with Ecuador society through agricultural intensification and market integration in six provinces of the Sierra: Imbabura, Tungurahua, Chimborazo, Cañar, Azuay, and Loja. Though individual haciendas had regularly brought in technical expertise from Europe and the United States since the late 1800s, the Andean Mission represented the formal arrival of the technical expert and the project on the behalf of rural communities. Additionally, the Cuban Revolution in 1959 marked a period of intensive social and political agitation throughout Latin America among both rural and urban poor, especially students and intellectuals. In Ecuador, these international events combined with deepening protests and violence in rural areas led to policy discussions over agrarian reform, which were high profile and captured public attention. Two years later the US arrived with the aforementioned Alliance for Progress program.

In 1961, Ecuador's military government created the *Instituto Nacional de Investigaciones Agropecuarias* (INIAP) for the purpose of "elevat[ing] the productivity of human and natural resources through the generation and adoption of technologies of easy diffusion and application…"[9] INIAP was charged with two specific objectives: 1) to investigate, develop and apply scientific knowledge and technology for the exploitation, utilisation, and conservation of the natural resources in the agriculture sector, and 2) to contribute to increased production, productivity, and the qualitative improvement of agricultural products, through the generation, adaptation, validation, and transfer of technology. In 1964, the government created the *Ministerio de Agricultura y Ganaderia* (MAG) charged with "promot[ing] and diffus[ing] the results of research and experiments produced by INIAP and other public and private industries."[10]

Initially MAG was provided considerable resources, and its administration and operations were centralized in Quito (Barsky and Cosse, 1981). Through the processes of "government modernisation," based on ideals of market liberalisation, the progressive privatisation of natural resource ownership, and the elimination of public services, MAG was weakened considerably. In the course of time, the Ministry underwent a major restructuring to "decentralise" decision-making and operations to the provinces. The Law of Agricultural Promotion and Development (1979) and the Law of Agrarian Development (1989) shifted MAG from a primary provider of technical services to a more passive role organised around the production of capacity-building plans, the "arbitration" of training responsibilities, the "coordination" and "normalisation" of the agriculture sector, which included the regulation of private property rights, "fair and open competition," free importation of inputs, improved seeds, animals, plants, and machinery, "unfair competition" from foreign countries, "administrative skill-building," and credit for agribusinesses.[11]

Similarly during the 1980s and 1990s government restructuring weakened INIAP. While the rhetoric of agricultural research survived, INIAP became the *Instituto Nacional Autónomo de Investigaciones Agropecuarias*, shifting it from a public-run research organization to a "decentralised, private entity with a joint social and public mandate with economic, administrative, financial, and technical autonomy..." In the process, the semi-private Institute gained control over its infrastructure, including four major research stations and three sub-stations, and a special public budget for "advancing scientific research, generating, validating, and diffusing technology in the agriculture sector." Despite its new status as an autonomous entity, through the 1990s to date salaries and the vast majority of INIAP's operational budget continued to come from public sources, though during that period its budget decreased markedly.

Carchi: model of modern agriculture

The national agricultural research institutes in Latin American generally followed the US land grant model of technological development, particularly through intensification of

[9] Supplement, Official Government Registry Number 315, 16 April 2004.
[10] *Reglamento Orgánico Funcional* del MAG. During the shift towards oil exploitation in 1970, the military government combined the MAG and the Ministry of Industry into the Ministry of Production. In 1973, MAG was re-established as an autonomous ministry.
[11] Supplement, Official Government Registry Number 315, 16 April 2004.

production through market integration, mechanisation, and the use of agrochemicals (Flora and Flora, 1989). Beginning in the mid-1950s, this included the “green revolution,” the development and application of genetic technology to alter the growth and productivity of crops and animals. This period also saw the institutionalisation of waged labour, including paid teams of specialized migrant labour, known as *cuadrillas* or “squadrons.” Carchi expressed these patterns of development more clearly than the rest of Ecuador and, as a result, the province has been described as a model of agricultural modernisation.

According to Barsky and Cosse (1981), unique conditions in Latin America interfered with externally-led policy and technology development processes in Ecuador. At the Spanish arrival, agrarian societies were restructured around the interests of extractive enterprises oriented around export markets. Following the 1930s, this arrangement was transformed by a new industrial era of order organized around diverse articulations of import substitution. These phenomena were accompanied by emergent conflicts and contradictions between more recent industrial and earlier agrarian order, sustained by the monopolization of resources and control over surpluses of production and the realization of emergent industrial social forms as the principal means to wealth accumulation. In practice, these conflicts expressed themselves as political in-fighting among divergent interests that effectively divided the State between internal social structures and modern industrial perspectives, often supported by international politics and industry. This inevitably led to structural "incoherencies" that influenced policies and generated political battles, antagonism, isolation, and ultimately, disputes for control over the State and its projects. While this phenomenon was generally true for the Ecuadorian highlands, Carchi was another story.

Rural communities of Northern Ecuador were transformed to what Barsky (1984) described a "bimodal system" dominated by two principal actors: large farmers who had undergone processes of technification and capitalization, and smallholders, likewise transformed by a degree of technification but lacking land or capital resources, who achieved only limited accumulation from within this context. Following agrarian reform, *Carchense* agriculture underwent profound technological change that at first fuelled sharp increases in potato production and productivity. These developments occurred concurrently with the conformation of new State apparatus as a result of the problematisation of the agrarian and agricultural concerns and its orientation towards modernisation through common patterns of technology development and diffusion. More than anywhere else in Ecuador, farmers in Carchi widely accepted the recommendations of the emerging network of agricultural experts and support agencies. Within five years of agrarian reform, essentially all farmers began to organise their production around commercial markets and externally based technology. They adopted mechanized tillage, synthetic fertilizers and pesticides, and new potato varieties, as well took on debt.

Agrarian developments in four villages

To understand rural transformations in Carchi since the hacienda period, I conducted in-depth case studies in three villages: San Pedro de Piartal (Piartal), Santa Martha de Cuba (Cuba), and San Francisco de Libertad (La Libertad). Since 1998, these had been the locations of multiple CIP and INIAP studies, including those of the Eco*Salud* project to be discussed in Chapter 5. All three locations had been part of the described economic and health research, and self-selected groups of farmers took part in Farmer Field Schools. Due to a long history with farmers in these villages, the Carchi Research Team and I were provided broad access to individuals and their families that were generous in working with us to shed light on the local experience with agrarian reform. In addition, Myriam Paredes (in process) and I added a fourth community, Mariscal Sucre (Mariscal), due to its unique settlement history and recent involvement in development and conservation activities, including the Farmer Field Schools.

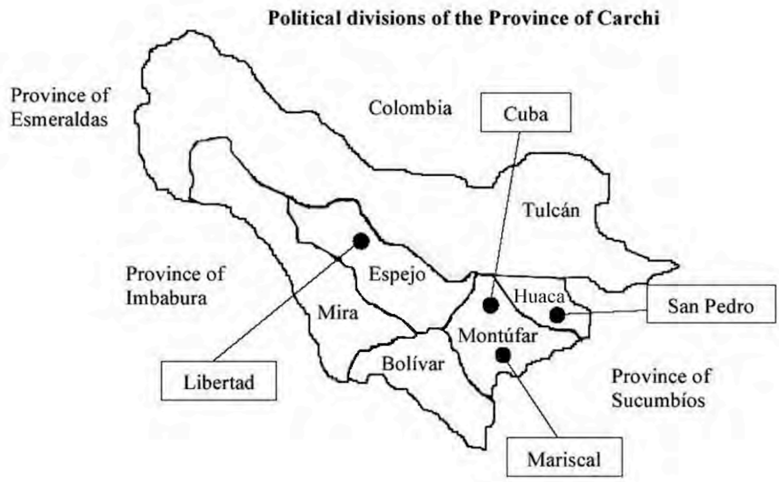

Figure 4.1 Map of case study sites

While farmers generally agreed upon certain dramatic moments of change, as Paredes (2001) reminds us, in Carchi there existed substantial variation in how individuals, families, and communities responded to emerging events. In her research on both commodity and non-commodity circuits, Paredes identified four farming strategies that dominated the mediation of modern social fabric in Carchi, with groupings described locally as: *riesgosos*, *intermedios*, *pragmaticos*, and *jornaleros*. These divergent "farming styles" illustrate degrees of autonomy, but also the varying effects that commoditized forms may or may not have had on particular values and relations, depending on the specificities of local circumstance and what became central to providing value to goods and relationships. Diverse family-level phenomena are the focus of Paredes (in process). This chapter limits analysis to global socio-technical phenomena.

During the period of 2003 to 2004, Paredes and I employed a farmer from each of the four communities who implemented weekly registries of agricultural activities throughout the potato-growing season. Three of the recorders were FFS graduates with whom we shared a long history of interaction. These people had strong knowledge of agroecology and especially Integrated Pest Management and were part of broad social networks with people both inside and outside the FFS movement. The fourth person was a female leader from Mariscal who had worked closely as an extensionist with the Jatun Sacha Foundation, a conservation organization, and more recently with EcoPar, an environmental consulting firm.[12] She was highly experienced with community forestry and had a broad social network of people both inside and outside the conservation activities. The farm registries were digitalized into a database (referred to here as "Paredes and Sherwood database, 2004"). The plots were selected based on two criteria: 1) willingness to participate in weekly recording of production activities throughout the growing season and 2) social diversity, as per the farming styles determined in the social heterogeneity study of Paredes (2001). To assure a robust sample size for standard statistical analysis, we sought at least ten percent of the farm household population in each community. In the end, a total of 94 fields from 92 farmers were documented (at least 10% in each community and over 12% of the overall population). Paredes (in process) provides further details on the size and social heterogeneity of the sample selection. This database complements the earlier CIP and INIAP studies and gives insight into changes since "dollarisation."[13]

My mixed role as intervener-researcher in Carchi raised objectivity concerns, posing methodological challenges. This included both my ability to dispassionately listen to informants and interpret experience as well as to receive unbiased information from others. Additionally, over the years I expressed my perspective in publications, public events, and the media, and many farmers, public officials, and industry representatives were aware of my positions. As a result, people tended to tell me what they thought I wanted to hear. Paredes faced similar challenges. Consequently, it was difficult for her and I to obtain objective information during interviews.

To overcome this obstacle, Paredes and I employed a team of four Ecuadorian *técnicos* – an agronomist, forester, economist, and sociologist, who conducted interactive research on political history, social developments, farming changes, and market integration across the four sites between January 2003 and August 2004. We added additional people when research demands were high, for example during planting periods. We trained the team in quantitative and qualitative research techniques, as per the demands of specific inquiries. Throughout that period we held regular bi-weekly meetings to discuss findings and revise on-going studies. The team and I taped and transcribed interviews of individuals and group discussions, and we took copious notes during field visits. Unless otherwise stated, the quotations reported here are from that material. The research team collected secondary data, it conducted interviews with farmers, agrochemical salesmen, industry representatives, public officials, and technical specialists, made homes visits, and held meetings with focal groups to discuss and review findings. Individual members generated raw data (e.g., notes, interview recordings, and surveys) and produced technical reports on topics of particular interest (e.g., the arrival of the tractor and agrochemicals or the loss of local potato varieties). This material was presented to other team members and discussed as a means of further cross-checking findings. The research concluded with a series of workshops both in

[12] Jatun Sacha Foundation established and set up the Guandera Reserve in 1991 and had a long history of working with Mariscal Sucre on the conservation of the remaining track of forest. EcoPar was a three-year IDRC-funded project to address concerns over the sustainable management of biodiversity of the eastern Andean flank. Over the years, we had developed close relationships with project leaders from both organizations and often shared human and material resources to advance tasks of mutual interests.

[13] Dollarisation was the name commonly given to the Ecuadorian currency conversion from the Sucre to the US Dollar in March 2000. I will further discuss this policy and its effects later on in this chapter.

and among communities from May to July 2004 to review findings and to synthesize conclusions across studies.

I go on to summarize how farmers in each of the four research sites described major events of agrarian development following land acquisition. I then examine the evolution of technology and social transformations in recent time.

Post hacienda land redistribution and settlement

El Vínculo Hacienda originally extended the length of the eastern Andean ridge from the Chota Valley north to present-day Huaca, an area of tens of thousands of hectares. At the beginning of the twentieth century it was owned by Ignacio Fernández Salvador. Upon his death, the hacienda was divided among family members into three smaller haciendas: Mata Redonda, El Salado, and Indujel. By mid-century, the parish of Mariscal Sucre and the town of San Pedro de Piartal would emerge from these haciendas. The generally drier and less fertile western flank of the Andes contained a larger number of smaller haciendas, where *wasipungeros* generally were mistreated, in part so that the administrators could meet profit margins. Relatively violent processes of land reform in the early 1970s of two such haciendas – El Quatis and La Rinconada – would lead to the settlement of the towns of Santa Martha de Cuba and San Francisco de Libertad. In continuation, I present how groups of farmers in each community accounted their general modern history – i.e., since obtaining land, becoming active in the market, and ensuing technological and economic development. In addition to following this structure, the cases are presented as per the particular emphases that emerged during interviews.

Mariscal Sucre: "groundbreaker in colonisation"

> The agrarian reform [of the 1960s] did not affect the people of Mariscal because there were no [traditional] haciendas in Mariscal when the laws came into effect. – elderly farmer from Mariscal Sucre

The village of Mariscal Sucre was a groundbreaker in colonisation. Some thirty years prior to land reform, a collection of smallholder farmers purchased the land that would become the present-day community. Large landholders of the region did not escape the great economic depression of the 1930s. More dependent on foreign exchange than Ecuador, Colombia was hardest hit by the Great Depression and suffered relative devaluation of the Peso. During this period, numerous Colombians migrated across the border and into Carchi in search of land and opportunity. In 1932, Clodomiro Aguilar led 11 farmers from the nearby *Carchense* town of Huaca to purchase 800 hectares of essentially abandoned steep forested land through an independent arrangement with the hacienda owner, Ricardo Fernández Salvador. This area became the "People's Agricultural Colony of Huaca" and later the Parish of Mariscal Sucre. The land was mortgaged to a national bank, and the purchasers took over that debt, paying three payments each of 63.11 Sucres (S).[14] The families distributed land via a lottery system, with lower lying forests designated for agriculture.

[14] The value of the Sucre in 1932 was Sucres 5.48:1US Dollar.

The *wasipungeros* of El Salado generally liked Ricardo Fernandez Salvador. According to the child of one of Mariscal's founders, "I remember Don Ricardo, who like most from the city was a tall man. No, he was extremely tall, but for some reason he could not walk. The workers' children used to volunteer to help him. Two by two, we'd spend a day under Don Ricardo's shoulders, helping him to get about." In addition to the 800 hectares of land sold, Ricardo Fernández Salvador donated 16 hectares at a lower margin of the colony for the construction of a town centre, where in 1936, the colonists responded by building a public primary school and, in 1940, a church.

The modern town centre of Mariscal Sucre was located about half way up the eastern ridge at 2,900 meters above sea level (masl) and had a population of about 2,500 people, who were distributed among six neighbourhoods and five smaller settlements. Over 90 percent of the town's denizens were Catholic. The chief economic means came from farming the potato-pasture system. The parish included the private Guandera Reserve, the largest track of remaining inter-Andean mountain forest. Today, the El Salado Hacienda continues to cover about 300 hectares and is run by the previous owner's son, Pedro Fernandez Salvador, who was one of the country's largest potato producers and who owned a herd of nearly one thousand meat and dairy cattle.

Initial settlement activities centred on "taming" the dense mountain environment. This involved felling trees and burning logs for sale as *carbón*[15] in the nearby markets of San Gabriel and Tulcán, where it was subsequently redistributed for a profit to larger markets in the cities of Ipiales, Colombia and Ibarra and Quito, Ecuador. A dense, wet montane forest covered the hillsides. According to an elderly man who helped clear the land, "I remember when we arrived and looked up at the inhospitable forest. The first thing we had to do was throw the mountain onto the ground. We cut down and burned the trees, and then burned them again, before we could actually see the ground. Only then could we think about planting."

"In order to survive, we had to dedicate ourselves to *carbón* production. There was no other means of income. In exchange [for *carbón*], we paid off our land debt and brought rice from Julio Andrade and San Gabriel."

In those days, Mariscal was not connected to the Pan-American Highway, so charcoal had to be carried down the mountainside on horseback. Charcoal extraction was an important source of income for decades. By the end of the 1960s, however, the forest resource finally depleted to the point where charcoal increasingly was no longer a viable means of income for all but a small minority of the population.

"The forest ran out by 1970. Each family had its block of forest that ran out, and [as a result] had to turn toward something else." Nevertheless, a small number of families continue to rely on charcoal production and commonly employ teams of labourers from

[15] Carbón or 'charcoal' refers to the partially burnt carbon mass leftover after the oxidation of wood and other organic material that people from Carchi commonly used as an energy source for cooking and heating prior to the arrival of electricity and natural gas in the 1970s.

Colombia to fell the remaining outcroppings of forest hanging stubbornly to the steep mountainsides.

The people we interviewed recalled that, previously, the sale of five to six mules (200 pound loads each) of charcoal would meet a family's financial needs for a year. Following deforestation, land slowly became converted to subsistence agriculture. Initially, families sold charcoal and purchased grains from the drier region of La Paz. Due to the harsh cold and wet climate of the time, cultivated crops were limited to Andean tubers, oca, melloco and mashua that were planted among the tree stumps and underbrush with a shovel-like tool. Families usually reared guinea pigs in homes, and free ranged a gaggle of chickens. Typically, each family reared a pig for consumption during holidays, such as Christmas, Holy Week, and the town's patron saint day. As the forest disappeared and the weather dried, soils drained to the point where farmers could plant potato, quinoa, maize, fava bean, and lupine.

In the 1960s, a wave of new colonists, primarily of Colombian origin, arrived to exploit *carbón*. Many early colonists sold land and migrated to urban centres, especially Ibarra. This caused conflict with the founder, Clodomiro Aguilar, who found his leadership challenged. In light of the emerging land reform policies, Clodomiro left Mariscal and organized a new group of colonists to seize land in nearby Monte Olivo and later Santa Martha de Cuba. The town's people built a new and larger Catholic church. At the end of the 1960s, Ecuador decided to begin to exploit its oil reserves, of which a portion of profits was "planted" or invested in development, which included rural infrastructure development.

In 1970, under a cost-sharing arrangement through *mingas* (a Kichwa word for communal labour), the government financed a potable water project in Mariscal. In 1975, Mariscal purchased a small diesel electrical generator that provided electricity to a handful of stores and houses located at the community's centre. That year, a family bought a small black and white television, which became very popular. Through *mingas* and local government donations, the town constructed a water drainage and sewage system that connected houses in the urban centre. In 1979, the community and the Ministry of Education built a public high school. Electricity was installed in the early years of the 1990s. While a single telephone line reached the community in 1985, it was not until 1992 that a central network was established and individual houses received telephone service. In the mid-1990s, the non-governmental organization Jatún Sacha purchased a large section of surviving forest and *páramo* and established the private Guandera Biological Reserve.

Over the years, the Church congregation had been haunted by the theft of a number of religious artefacts, beginning in 1950 with the theft of the Rosary Virgin from the parish centre of Huaca. In 1980, the Virgin of San Vincent and the Jesus child were stolen from the church in Mariscal, which interrupted many traditions, including the "Castle of Fruit" that involved the construction of large structures ornately decorated and filled with fruits during the town's patron saint day. In the late 1980s, the congregation collected donations and commissioned a replica of the Rosary Virgin, but tragically, that statue also disappeared in 1993. According to many townsfolk, since that period Mariscal had given in to "modernity." Fireworks replaced the "Castle of Fruit" tradition, and rather than celebrate together during festivals, neighbourhoods began to compete with one another. In reference to these developments, one elderly woman declared, "The meaning of faith has changed."

San Pedro de Piartal: "no longer dirty carboneros"

San Pedro, a town lying on the edge of the Parish of Piartal, is situated at about 2,800 masl on the eastern flank of the Andes, just south of Mariscal Sucre. The area largely was part of the 4,000 hectare Indujel Hacienda, which was a subdivision of the larger El Vínculo Hacienda. Indujel chiefly produced potato, wheat, and barley on the lowlands. The area that would become San Pedro was part of a forested mountainside, thought too steep and dense for agriculture. The rainfall gradient decreases as one travels south along the eastern Andean ridge, so while Mariscal received greater amounts of rainfall (about 1,050 vs. 950 mm/year), Piartal's climate remained relatively wet throughout the year.

In 1942, the El Salado Hacienda sold 1,200 ha of prime land for S219,000[16] to a group of 45 relatively wealthy individuals from San Gabriel as well as several groups of smallholders who bought into the purchase with the help of a state-owned bank.[17] Meanwhile, in 1945, Luis del Campo Fernandez Salvador took over the Indujel Hacienda and began a slow process of modernisation through mechanized tillage, the introduction of agrochemicals, improved pastures, and new races of cattle.[18] The people we interviewed claimed that Indujel workers suffered poor treatment from its Colombian caretaker. According to one respondent:

> The caretaker marched about with dogs and large *juetes*, and when workers did not hurry up, they whipped them. Sometimes they sicked the dogs and people were bitten. That was a time of slavery, [a time of] true poverty. Now people say that we are bad off, but they're wrong. Poverty was in that time because the people, our parents, were peasant workers. Children stayed home in the house and cried, because there was no one to give them attention or give them food.

The El Salado sale and continued mistreatment raised expectations among the *wasipungeros* of the Indujel Hacienda. Nevertheless, it was not until 1964, under mounting pressure from the Agrarian Reform Law, that Luis del Campo relinquished control. An elderly woman explained:

> Our grand illusion was to own something, to advance, to have a place for your children to live and work without having to pay rent. As a consequence, several of our leaders met, and a group of people came out of hiding and they met right there [pointing] at the land divide. There is where it all began. They told the different families to take possession of a selected plot of land. Beneath that tree that you see there, my family built a little hut, bringing with us a load of páramo grass [for the roof]. They carried my mother and me in a hammock. I had just been born three

[16] The value of the Sucre in 1942 was about S.14.20:1USD.
[17] *Revista Los Arayanes*, No. 5. September 2003.
[18] *Revista Los Arayanes*, No. 2., September 1996

> days earlier. Folks told my father that he was crazy, that they were going to kill his *mujer*.

Another woman recalled, "There was a meeting in San Gabriel during which the leaders asked us, how are we going to be slaves to the *patrones*? They said that now there is a law, and they proposed that we create a union to reclaim the land that we work for nothing. Over 200 people signed an agreement. We set a date and during the night moved together and sat on the land."

In 1964, Luis del Campo entitled plots of land as retirement for his most faithful workers, and he sold a single concession of land to about 250 ex-*wasipungeros* who had formally organized themselves with state-sponsored financial support and legal representation. Eighty percent of the ex-workers were of Colombian origin. As in Mariscal, the colonists distributed land among its members through a lottery. The average price was about S100 per hectare,[19] and plots were commonly distributed in lots of ten hectares. Today, the Fernandez Salvador family continues to operate the Indujel Hacienda that covers an area of about 300 ha.

An elderly man told me that there was a saying in Carchi, "When a child is born, the forest shakes in fear." As the most accessible forested areas near Mariscal became depleted, the *charcoaleros* migrated south towards present-day Piartal. In 1946, the road reached San Pedro, providing easy access to the forest. This activity heightened following the colonization of the Indujel, with *carbón* sold principally in San Gabriel. Interviewees claimed that the activity was not highly regarded and that townsfolk degradingly referred to the people from Piartal as the "dirty *charcoaleros*." Between 1970 and 1975, the farmers of Piartal actively began to market potatoes in San Gabriel and Ibarra. Nevertheless, bartering practices continued until the 1980s, with guinea pig, bread, and potatoes exchanged for wheat. While entirely Catholic at the moment of settlement, over the years, Piartal had become increasingly divided between Catholic and Evangelical faiths. When we visited in 2004, about 25 percent of families claimed allegiance to the latter.

Santa Martha de Cuba: "inspired by the Cuban revolution"

Recently, Santa Martha de Cuba changed its name to Cuba. Different from Mariscal and Piartal, the remaining communities of Cuba and San Francisco de Libertad were established during the agrarian reform period, but through far more conflictive processes of forced land acquisition, followed by violence on the part of the hacienda owner and, in the case of Cuba, the military. The area of present-day Cuba was part of the Quatis Hacienda owned by Army Commander Guerrón. Unlike El Salado, Guerrón did not intensively manage Quatis nor did he seek to increase production through the use of modern technology. The hacienda was situated at the foot of the western Andean ridge that had been deforested long ago. As a result, the land was significantly drier than that of the eastern ridge. Additionally, the hacienda was located at lower elevation and on more even terrain than that of the other case study sites. In 1970, the workers and volunteers from neighbouring

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[19] The value of the Sucre in 1964 was about S.18.00:1USD

villages seized land that would become present-day Cuba. The village, located at about 2,800 masl, in 2004 was composed of about 250 households.

When I asked about life on the hacienda, a man responded, "We had to be responsible before the patrón; day and night we had to do what the Patron said." In the late 1960s, the Quatis hacienda was in general neglect. The cattle herd was poorly bred and managed, pastures were overgrown and underutilized. Infrastructure was in disrepair. Originally, Commander Guerrón wanted to independently sell the land to the *wasipungeros*, but he refused after they failed to organize themselves into a viable cooperative and raise sufficient funds.

As with Mariscal Sucre in the 1930s, Clodomiro Aguilar played a role in the settlement of Cuba forty years later. In 1970, following the leadership of Galo Sierra, an organiser from IERAC, Aguilar helped to establish the "Cooperativa La Calera." That year, nearly 70 *wasipungeros* combined with several dozen people (*oportunistas* or opportunists) from the villages of Monte Olivo, Huaca, and San Gabriel invaded a large section of the hacienda. Guerrón protested and sent in armed soldiers to throw off the settlers. After bloody confrontations and deaths on both sides, the government intervened. The land was adjudicated to IERAC and sold to the settlers. As elsewhere, following land acquisition the settlers distributed the land among the group under a lottery arrangement.

Many of the initial settlers of Cuba were opportunists. One of the original settlers told me, "The first inhabitants sold their land and went to live in Ibarra, San Gabriel, and Huaca. This opened the way for other people – *campesinos* – who had always been there and really needed land, to purchase it and begin to earn a living."

The first settlers in Cuba looked to the little remaining forest for immediate income needed to pay off the government loan and to plant the new economic crop: potato. According to a founding member, "In order to cover the costs of our first potato crops, we let people cut down forest. The wood was turned into *carbón* and sold in Tulcán." By the end of the 1970s, deforestation and charcoal production opened the way for widespread potato production.

Like farmers elsewhere, the people of Cuba quickly learned to use agrochemicals. "Mancozeb enabled us to control late blight. Carbofuran enabled us to control the *gusano blanco* [the "white worm" or Andean weevil]. These are no longer problems for *real* potato farmers. The only pest that has been able to take us by surprise is the Guatemalan potato moth." The soils were relatively poor in Cuba, so fertilizers were particularly important. As conditions with their government loans, farmers adopted new varieties, fertilizers, and pesticides. First, these arrived through the Ministry of Agriculture, and later, they purchased them from the new agrochemical stores in nearby San Gabriel. Several farmers told us about 4-H volunteers from the US who arrived in the 1970s to teach them how to use fertilizers and how to breed animals. The Guatemalan potato moth arrived in the late 1990s. During dry years, such as 1998, it completely devastated crops. "We did not even bother to harvest. We hoped the worms would die of *empacho* [bloat] in the ground."

In the late 1990s, a handful of farmers began to reorganize production around broccoli under contract for export companies such as AgroFrio. Beginning in 2000, purchasers started to refuse harvests, usually making questionable claims that the crop did not meet quality standards. As a result, farmers sold harvests in Ibarra at a significantly lower price than that agreed under contract. Combined with inflation associated with the introduction of the dollar, this led to bankruptcy for many. Such losses and unfair treatment became public, and farmers increasingly lost interest in contract production with companies. Many farmers turned to milk production. "When we see no way out, we stop spending money, which means we cannot plant potatoes. Our cows keep us alive. When a farmer sells his cows, you know he is no longer alive." Since dollarisation, many people in Cuba sold off their land and animals and migrated to Tulcán, Ibarra, and Quito.

San Francisco de Libertad:" freed from slavery"

Previously known as Aliso, in 1696, the settlement of the modern-day Parish of La Libertad included about 40 indigenous families (Miño, 1985). By that time, the Spanish controlled all the land. The community of San Francisco is a *caserio* (or neighbourhood) of La Libertad, which is located a few kilometres above the town of El Angel, the county seat of Espejo. San Francisco de Libertad is situated in the uppermost reaches of the páramo of the western Andean ridge between 2,900-3,600 masl. The zone is wet (1,100 m/yr of rainfall) and cold (average yearly temperature of 10 °C). Similar to elsewhere in highland Carchi, the soils are deep, black Andean formed on top of *cangahua* (cemented volcanic ash) subsoil.

By the end of the nineteenth century, a handful of haciendas essentially covered the cultivable regions of La Libertad and El Angel (Miño, 1985). Two of these controlled the vast majority of area: La Rinconadita and La Riconada. The European textile crisis at the end of the eighteenth century greatly weakened these haciendas, which were largely dependent on the international wool market. By the beginning of the twentieth century, the traditional families dating back to the Spanish arrival would lose control over these haciendas, and they would be bought out by new business people who earned their wealth in nearby cities and through controlling transport of the growing trade between Ecuador and Colombia at the end of the nineteenth century.

In a business venture with Rafael Tamayo, Francisco Galárraga, an aggressive salesman who owned mule teams that ran products between Ecuador and Colombia, purchased the Rinconadita Hacienda from Emilia Fierro in 1893 that was valued at about S13,000 (Miño, 1985). Six years later, in 1899, the same group purchased the Rinconada, the second largest hacienda in Carchi (after the Vínculo in San Gabriel) for about 50,000 Sucres. The value of these haciendas in Espejo skyrocketed during the early part of the twentieth century, in large part due to the growing traffic of commercial goods between Ecuador and Colombia but also do to their expansion. Both of these haciendas increased their territory during the early 1900s through buying out traditional *hacendados* and claiming unused regions of páramo. Expansion enabled them to increase earnings through renting land to other *hacendados* as well as charging *wasipungeros* for crossing rights (i.e., the privilege of travelling through the hacienda), wood, water, as well as land for planting crops and foraging animals.

By 1920, the Riconadita land was valued at S50,000 and the cattle S15,756.[20] At this time, the Rinconada Hacienda was valued at S175,000 and carried 3,500 head of cattle valued at S63,552. The Tamayo brothers were known as progressive *hacendados* and early adopters of new technology. They were the first to import Holstein from France, which subsequently were crossed with cattle from neighbouring haciendas.

In 1945, the *Cooperativa de Crédito, Producción y Consumo* "Eugenio Espejo" and the *Junta Central de Asistencia Pública* managed to obtain a land access and production contract with the nearby Pucará Hacienda. The following year, landless members of the cooperative and from surrounding areas occupied the hacienda, which led to an open conflict with the *hacendado* and contributed to similar uprisings in other parts of the highlands. A decade later, in 1956, President Ponce Enríquez initiated a process of land distribution of the Pucará Hacienda, which some would describe as a predecessor of the 1964 Law of Agrarian Reform (Barsky, 1984).

When I consulted people of La Libertad about their history of land settlement, the first response was: "There was no liberty during the haciendas. We had to work all the time, even when we were sick." Nearly everyone worked in the Riconadita Hacienda. The *peones* (peasants or *wasipungos*) lived on the hacienda and were given access to land and in-kind payment through harvests. *Ganadores* were landless people who lived off of the hacienda and worked in exchange for pay. In 1970, the pay for adult male labourers was two *reales* per day. Women and children were expected to work for free. The children threshed and washed wheat and barley. Older people dug and maintained irrigation ditches. Women cooked for the *mingas* and milked cows. The *wasipungeros* received a yearly ration of food as payment for labour. For example, in the 1970s, they received seven *quintales* (one hundred pound sacks) of wheat, seven *quintales* of barley and two *quintales* of fava bean. The value of this food was discounted from their salaries.

In the late 1960s, a company arrived in La Libertad to exploit the wild plants pyrethrum and *guanto* for the production of botanical soaps, medicines and pesticides. Milton Vaca, from the *Federación Nacional de Organizaciones Campesinas* (FENOC), led the creation of the "*1 º de Mayo*" syndicate. When the company went bankrupt and closed down in 1972, Vaca reorganized it into the "*Asociación 23 de Julio*" that quickly grew to about 180 farmers, made up of *wasipungeros*, local landless, and migrants from Colombia. In late 1972, the Association invaded hacienda land in and around La Libertad. This led to violent repression that resulted in multiple deaths and the imprisonment of its leaders. The government, in particular IERAC, stepped in to mediate. Due to the political environment at the time, the *hacendados* were worried about further land invasions, so they decided to sell land, especially the less fertile degraded areas as well as the páramo. In 1975, the Association became legalised as a cooperative, and the land sale went through. By 1977, the government awarded the cooperative legal control over the land title. At that point, the Cooperative decided to divide up the property among its members through a lottery. Due to refinancing, the members did not pay off the original debt until 1999.

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[20] The value of the Sucre in 1920 was about S2.54:USD.

The *wasipungeros* and labourers from La Libertad generally were poorer just prior to land reform than those from the other case study sites. During the hacienda period, they lived isolated on the hillsides of the hacienda. Native forests and bush lands surrounded their communities, and water springs were ubiquitous. Nevertheless, the wasipungeros did not have rights to land, trees, or water. It was prohibited to pass through haciendas without paying a fee, which meant one had to walk around extensive areas – often thousands of acres, thereby greatly inhibiting circulation. During the 1950s and 1960s, the population grew and exceeded employment opportunities on the haciendas. People began to migrate in search of work. Up through the mid-1970s, houses continued to be made of traditional *bahareque* (dried mud and grass), and people slept on animal hides on the floor. Most people walked barefoot, but many men wore *alpargatas* (sandals made of rope) followed by *quelales* (sandals with rubber soles).

Following the break-up of the haciendas, the people of La Libertad began to work their own land. Relatively isolated from Colombia by the páramo, people tended to employ local labour through families or landless labourers living in and around El Angel and La Libertad. Sharecropping was even more common than in the other case study sites, with one partner contributing the land and the other labour and inputs.

When I asked what was traditionally grown, an elderly farmer responded, "On the *wasipungo*, we grew more or less the same crops as the hacienda: favabean, wheat, barley, potatoes, melloco, and oca. We planted potato in small plots using *wachu rozado*. Only the hacienda had a tractor. We kept our own varieties, some of which were purple and black and not liked by the *mayordomo*. We ate everything we grew, so we did not care."

The haciendas became modernised prior to land reform. The Riconadita used tractors, fertilisers, and pesticides. The haciendas also introduced the back-pack sprayer. With market integration, the emergent class of smallholder farmers began to earn money, which they invested in fertilizers to improve production. MAG introduced the compound fertilisers 10-30-10, 8-20-20, and 15-15-15 as well as a number of pesticides. Manzate (a mancozeb-based product) was the first fungicide to appear and was used for late blight in potato. The first insecticides to arrive were DDT and parathion, which were used for everything – from treating tubers to foliar pests to controlling lice on chickens and children. The insecticide Monitor (methamidophos) followed. People were unanimous that the 1970s brought prosperity to La Libertad. "Life was sad and hard. Later, people began to live well, now that they have opportunities."

In 1980, a road was built that linked San Francisco to La Libertad and El Angel, which provided access to the city of Ibarra. During the 1980s people stopped growing barley in response to low prices. Similarly, farmers stopped cultivating lupine and fava bean. Families managed a similar crop rotation: two years of consecutive potato followed by five years of pasture as a fallow. Sometimes farmers would grow three cycles of potato or they would shorten fallow periods, but the Andean weevil populations would become so bad that not even carbofuran would control it. As a result of a shift from farming for community consumption to supplying markets in Ibarra and Quito that demanded Superchola, in 1993, the community lost the local potato variety *Morasurco*.

By the mid-1990s, potato production began to fail. This situation was particularly problematic in La Libertad where the altitude and cold weather made potato the only viable alternative. One farmer explained, "The soils became tired, and we no longer could produce as before. Earlier, we would get 30:1. Now, we are lucky to get 10:1."[21] The 1996 El Niño brought two seasons of drought, followed by heavy rains in the North and multiple years of late blight problems and low market prices due to high production elsewhere and imports from Colombia and Peru. People increasingly turned to milk production, but the prices were not sufficiently high to cover living costs. With dollarisation, input prices doubled and tripled, fuelling a financial crisis and forcing many to sell their animals and land to pay off debts. As a result, many people became *jornaleros* for the larger landowners or they migrated to cities – commonly Ibarra or Quito – in search of menial labour. Often, children who had left for the city to study did not return to their villages. Following graduation, they commonly sought urban-based work and sent home remittances for their families. In numerous cases, young people who did not find opportunity joined the *guerrillas* (revolutionary groups) in Colombia. Dollarisation left the community of La Libertad in shambles.

Summary of the four case study sites

Each of the four case study sites was unique in geographical setting and history (Table 4.1). The founders of Mariscal Sucre and San Pedro de Piartal were pioneers of land reform, organising to peacefully purchase land from haciendas in the 1930s and 1940s, respectively. Those from Mariscal generally had been treated well under the hacienda system, while those from Piartal had received cruel treatment. Both communities were located on the steep eastern flank of the inter-Andean valley, with relatively fertile hillsides of deep black Andean soils, ample sources of water and large areas of native highland forests. From the beginning, their goal was individual land acquisition. The groups converted trees to charcoal to pay off land and transition to family agriculture as a means of livelihoods. Initially, each community developed relatively diverse cropping systems based on rotations of Andean roots and tubers with grains and pulses, which over time became converted to the intensive potato-pasture system.

The founders of Santa Martha de Cuba and San Francisco de Libertad were primarily hacienda workers who suffered cruel treatment and gained access to land through relatively violent means during the period of agrarian reform in the early 1970s. These communities were situated on the western flank of the inter-Andean valley, a region that was relatively dry and degraded at the time of purchase, especially the area of Cuba. Nevertheless, San Francisco was located high in the páramo. While the conditions there were cold and moist, the farmers of San Francisco benefited from ample soil and water resources. As per the agrarian policies of the time, both groups were obligated to obtain land through communal arrangement, and upon land acquisition, they were handed loans in the form of seed and agrochemicals. As a result, the groups immediately converted land to potato production

[21] The ratio refers to potatoes harvested to potatoes planted. Since farmers plant about 30 quintals per hectare, 30:1 signifies about 900,000 lbs of potatoes at harvest or 41 t/ha. By 2000, farmers regularly harvested 10:1 or 14 t/ha.

Table 4.1 Summary of case study sites

Characteristic	Mariscal Sucre	San Pedro de Piartal	Santa Martha de Cuba	San Francisco de Libertad
Descriptive motto	Groundbreaker of land reform	No longer "dirty charcoaleros"	Inspired by the Cuban Revolution	"Freed from slavery"
Geographical aspect and characteristics at acquisition	Eastern flank, 2,800-3,400 m, sloped to steep terrain; heavily forested	Eastern flank, 2,900-3,400 m; sloped to steep terrain; heavily forested	Western flank, 2,800-3,200 m; flat to sloping terrain; deforested	Western flank, 2,900-3,600 m; sloped to steep terrain; montaine environs
Natural resource base (soil, water and forests)	High	Medium	Low	High
Climate (avg. rainfall and temp.)*	1,050 mm/yr 11.5 °C	950 mm/yr 11.5 °C	800 mm/yr 12.5 °C	1,200 mm/yr 10 °C
Hacienda origin and relationship	Originally El Vínculo and then El Salado; eventually modern hacienda; good relations.	Originally El Vínculo and then El Salado, Indujel; modern hacienda; workers suffered harsh treatment.	El Quatis, traditional and poorly managed hacienda by absentee *Patrón*; workers suffered harsh treatment.	La Riconadita and Rinconada; modern haciendas; workers suffered harsh treatment.
Land acquisition and distribution	1932, 11 families from Huaca and organized by local leader; peacefully purchase 800 ha through assuming hacienda debt; land distributed by lottery.	• 1942, 45 outsiders peacefully purchased land from El Salado • 1960, 250 additional workers purchase land from Indujel under land reform; later lottery distribution.	1971, inspired by Cuban revolution, 103 workers and others organized by outsider; aggressive seizure and purchase of land; communal management; later, lottery distribution (1975).	1972, 180 workers organized and aggressively seized land; managed communally; later lottery distribution; 80 families sold land entitlements (1975).
Economic development	Charcoal exploitation (1930s-1960s); slow conversion to potato-pasture (1960-today)	Charcoal exploitation; large scale ('45-80); slow conversion to potato production ('70-75)	Immediate conversion to potato production and rapid technification (1975)	Subsistence production; landless labourers; conversion to potato and grain production following land settlement
Principal markets	San Gabriel and Tulcán	San Gabriel and Ibarra	San Gabriel and Tulcán	El Angel, Ibarra and San Gabriel
Population (2003)	200 households	120 households	250 households	180 households
Cropping development (from traditional to market integration)	From Andean roots and tubers, pulses and quinoa to potato, pasture for market	From Andean roots and tubers, lupine, maize, and quinoa to potato, pasture	From pasture to potato-pasture	From Andean roots and tubers, pulses, maize and quinoa to potato, pasture and grains

*** INAMHI data**

to generate income for the banks. Upon paying off debts, both quickly distributed land by lottery for individual ownership. In Cuba, about half of the founders sold their land entitlements and moved to urban areas. In Cuba, farmers had little option but to continue to rely on the potato-pasture system for livelihoods. Meanwhile, those in San Francisco also cultivated Andean grains and pulses. Overtime, however, the communities of Cuba and San Francisco – not unlike Mariscal and Piartal – came to concentrate on intensification of potato production as their chief economic means of livelihood.

Post hacienda land distribution and settlement was accompanied by different social trends in communities. The people of Mariscal – the "groundbreaker of land reform" – invested heavily in developing the community's infrastructure, including a cobblestone road, central park, potable water and electricity, church and public garden. On the opposite extreme was Cuba, which despite its location near the valley floor and closeness to the Pan-American Highway, at the turn of the twenty-first century still had dirt roads that became impassable during the rainy season, no central park, and less than adequate public services. While older people spoke nostalgically about land acquisition, youth generally did not have a clear understanding of histories. Despite substantially different histories, all locations talked about a common global trend. Land acquisition led to periods of opportunity and prosperity, when sadness and hardship became replaced by opportunity in the form of work and accumulation.

Nevertheless, this prosperity did not last. In recent time, communities experienced resource degradation (e.g., the "tiring" of soils and the "drying up" of streams), growing pest problems, rising input costs, price declines for their products, and new hardship. Different forms of social "decay" and "disintegration" accompanied this. When talking about recent trends, people mentioned: loss of community solidarity, conflicts over faith, abandonment of agriculture, sale of land, and emigration to urban centres. At all locations, people described unimaginable hopes and dreams associated with land acquisition during the second half of the twentieth century, followed by disappointment and concern for the future at the turn of the century.

Agricultural transformations and the performance of modernisation

To understand modern technical change in Carchi, I focused on the use of technology in potato production since land reform to provide an overview of major trends in cropping systems, varieties, pesticides, fertilisers, and tillage. I also examined economic performance of modern potato production. Information was gathered from secondary sources (MAG/INEC Agriculture Census of 2004, INIAP UVTT-Carchi, Crissman et al., 1998; Yanggen et al., 2003; Herrera et al., 1999; Pumisacho and Sherwood, 2002), surveys conducted by Paredes and Sherwood during the 2003-2004 cropping season, as well as semi-structured interviews. The 2003-2004 research team subsequently held focal group sessions with the 92 database participants from La Libertad (n=16), Piartal (n=34), Cuba (n=19), and Mariscal (n=25) to review, validate, and adjust global trends. Results from this research activity are subsequently cited as "Carchi Research Team, 2004."

Cropping systems

The hacienda and *wasipungos* of Carchi typically cultivated small plots of mixed crops containing Andean roots and tubers, fava bean, maize, quinoa, barley, and wheat. As *wasipungeros* moved onto their own land they carried with them seeds from the hacienda and began to plant around houses as well as freshly deforested areas. The research team found that in Mariscal, where farmers arrived some thirty-five years prior to commercial market integration, patterned cropping systems emerged that resembled traditional multi-cropping and rotations known elsewhere in the *páramo* Andes (Pumisacho and Sherwood, 2002).

In the 1950s, the town people of Mariscal introduced meat cattle from the El Salado hacienda to feed on outcroppings in cleared forest and areas under fallow. By the end of the decade, farmers reared about 100 head of cattle. They managed soil fertility empirically through multi-cropping and rotations with legumes, followed by recuperative periods of five to eight years. Guinea pig and cattle manure were applied to crops at planting. Sometimes farmers prepared botanical pesticides based on species such as *jun-jun* (*Pispura* spp.) for control of insect pests. Mixtures were carried in buckets and applied by hand. Nearby Piartal followed similar patterns, while the settlers of Cuba and La Libertad essentially arrived in the fervour of agricultural modernisation and as a result, immediately adopted industrialised production.

In the 1970s, potato became the first commercial crop of the agrarian reform beneficiaries throughout the four locations. By the end of the decade, potato monocultures quickly dominated the landscape. Agrochemical use expanded year by year through the end of the 1990s, when farmers began to leave land to pasture for dual milk-meat cattle due to the combined forces of production declines, climbing input prices, and falling market prices for potato. While pesticides generally enabled farmers to compensate for the intensification of potato production, the mid-1990s arrival of the Guatemalan tuber moth (*Tecia solanivora*) in an infested batch of seed from Colombia decimated potato production in Cuba, which led to a wide-scale abandonment of the crop.[22]

Between the mid-1970s and the end of the 1990s, the total area of Carchi dedicated to potato production increased from about 3,000 to 16,000 hectares.[23] This was followed by a sharp decline beginning in 1999, largely explained by increased input costs associated with dollarisation (An, 2004). The drastic decline in Cuba also was associated with three years of severe droughts that began with the El Niño in 1996 accompanied by the arrival and proliferation of the Guatemalan potato moth. The most recent 2004 census showed that only 6,179 hectares in Carchi were planted under potato. Since 1996, area planted to potato in the four research sites decreased dramatically, by about 60 percent (Figure 4.2). Only in La Libertad did farmers continue to maintain previous patterns of potato production, largely because of the town's altitude and climate that greatly limited alternatives.

The research team found that by 2004, farmers began to invest in improved pastures, for example through the introduction of rye grass mixtures as well as legumes, especially exotic

[22] Personal communication with Fernando Chamorro, INIAP-UVTT Carchi. December, 2001.
[23] INEC Census, 2004.

clovers. Families increasingly lived off of milk production that was sold for between $0.09 to $0.11 per litre (in 2007, the government increased this to $0.25/lt) to local distributors and processing factories, as well as the sale of beef cattle. Nevertheless, An (2004) found that dairy production was not an economic substitute for potato but rather a complement. In 2004, we found that many farmers had explored economic alternatives, such as fava bean, snow peas, and broccoli, but over time, these crops proved vulnerable to the extreme conditions of the northern highlands. As a result, crop failures became common, and increasingly, income from agriculture did not meet basic needs.

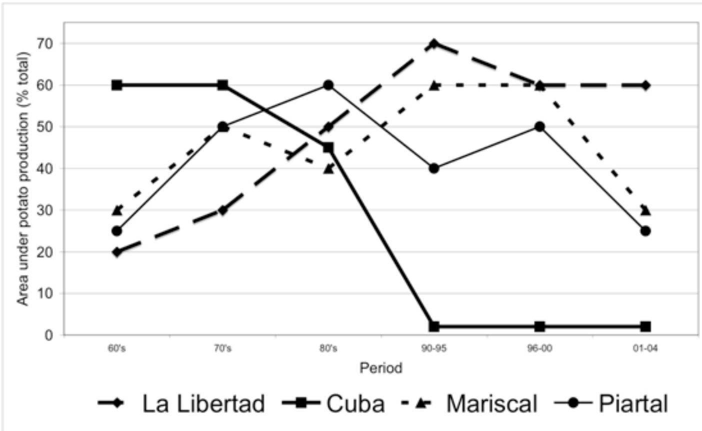

Figure 4.2 Average cultivated area under potato production (based on INEC data processed through focal group sessions by Carchi Research Team, 2004)

Potato varieties

Prior to agrarian reform, a large number of potato varieties were grown on the hacienda and on small plots in the *wasipungos* primarily for local purposes. Commonly, farmers on the *wasipungo* cultivated dozens of potato varieties, including numerous *chauchas* (or heirloom varieties) for household consumption. In the 1960s, the most popular potato was Curipamba, which represented about 40 percent of potatoes planted in Piartal and 20 percent in La Libertad and Cuba. Meanwhile, Chola was the most popular cultivar in Mariscal and represented about 30 percent of all potatoes grown. Some of these potatoes were traded with haciendas for sale in distant markets, but most of the potato crop was for subsistence consumption. As a result, local cultural preferences weighed heavily in cultivar selection. Farmers concerned themselves with conserving the favourite local varieties, among which were: Morasurco, Pintona, Ratona, Chala, Curiquinga, Sarda, Corneta, Aguacata, Morada, Morcilla, Manzana, Pan de azúcar, Pestañaroja, Papapiedra, Cuya, and Churo. At the time of our arrival thirty years later, few if any of these potatoes could be found in the communities. Of the 94 farmers surveyed from the four research sites during the 2003-2004 season, we found an average of 1.30 cultivars in their fields, with a maximum diversity limited to 3.0 (Paredes and Sherwood database, 2004).

The research team found that since market integration in the 1970s the number of varieties commonly grown in fields, including both commercial and heirloom cultivars, sharply decreased (Figure 4.3). As farmers began to produce for the markets in San Gabriel, Tulcán, Ibarra, and Quito, commercial varieties from Colombia arrived to supplant the local cultivars.[24] By the end of the 1970s the most popular potatoes were Ica-Huila (from Colombia), Curipamba, Chola, Guantiva, Violeta, Uva, and Martina. A decade later, a handful of highly commercial potatoes, particularly Chola, Superchola and Gabriela, dominated the landscape to the point where they represented over half of all potatoes planted (Figure 4.4).[25] During the 1990s Chola and Superchola came to represent about 70 percent of all potatoes grown in Mariscal, 60 percent in Cuba and 50 percent in Piartal, while only ten percent in La Libertad. By 2004 the percentage increased to about 90 percent in Piartal, 80 percent in Mariscal and Cuba, and 60 percent in La Libertad.

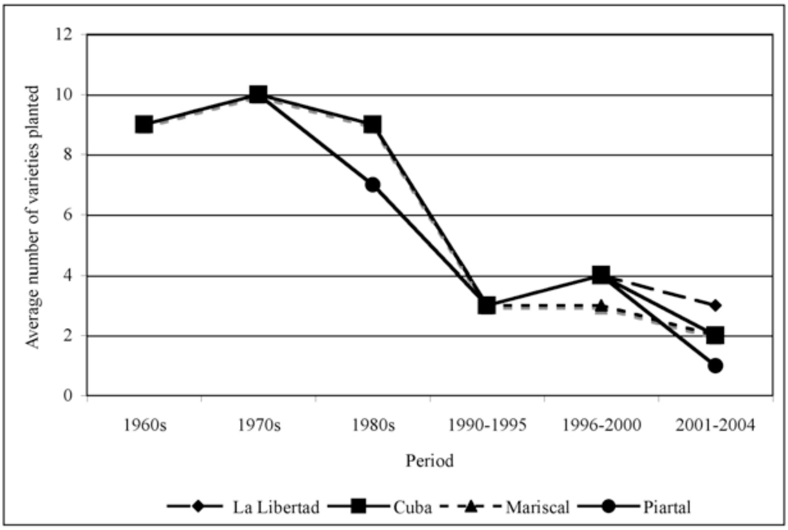

Figure 4.3 Average number of potato varieties found in fields (those covering > 5% of total area reported) (data generated through focal group sessions by Carchi Research Team, 2004)

The transition from the subsistence *wasipungo* system to landed smallholders who produced a cash crop for the market generated a loss of potato varieties. Farmers explained that this was due to market demand. Over time, they shifted to the variety that received the highest prices at the market. The popularity of varieties was determined by preferences in distant cities, independent of local environmental or cultural considerations. While Chola and

[24] It is technically illegal to import potato from Colombia for phytosanitary reasons, but in practice a vibrant trade exists.

[25] Ecuadorian consumers regularly confuse the varieties Chola and Superchola, both of which have similar red skin colour, off-coloured dimpled eyes, yellow flesh, large size, and oblong shape. As a result, the two commonly demand the same price in national markets. For the purpose of this study, I refer to Chola and Superchola as the same variety, unless otherwise stated. Technically, this is incorrect, but it is convenient for compensating for the inherent imprecision of historical analysis. In Pumisacho and Sherwood (2002), Superchola is correctly described as a cross between Curibamba Negra, *Solanum demissum*, and Chola. Curiously, Superchola, Ecuador's most popular potato, was not developed by the National Potato Program. Instead, an eccentric *Carchense*, Germán Bastidas, developed numerous potato varieties as well as breeds of meat and dairy cattle.

Superchola were difficult to grow and demanded heavy use of *remedios* ("remedies," a common metaphor for pesticides), these crops offered farmers the highest price at the time of harvest.

A number of factors governed market preference. Recently French fries and chips represented the principal increase in the potato market – from about five to ten percent of the national market (Herrera et al., 1999). The industrialisation of potato required varieties bred for consistent colour following frying, high dry matter content, and reduction sugars. In addition, the market for raw potatoes sold directly to household consumers was very resilient to change and tended to favour one or two varieties. The domestic market greatly preferred Chola and Superchola, which attracted a price commonly twice as high as that for any other potato. Urban consumers rarely recognized the variety they purchased. Instead, they simply choose a potato with a certain "look." Thus, a newly introduced cultivar, in order to be commercially successful, needed to be similar in appearance to Chola or Superchola.

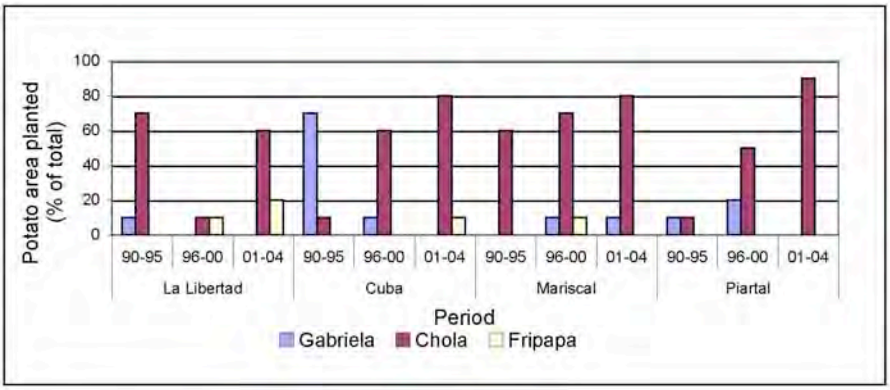

Figure 4.4 Average area planted under the three principal potato varieties (CIP and INIAP data processed through focal group sessions by Carchi Research Team, 2004)

The predominance of one or two market-ready varieties meant that farmers faced increasingly similar problems, and they had little to no local genetic recourse for addressing them. In Carchi, selectively bred varieties developed by local breeders or the national agricultural research service (INIAP) accounted for over 80 percent of the potato population found in fields. New varieties generally were crossed with genetic stock from previously popular varieties (usually to ensure market acceptability), thus further limiting actual diversity in the agro-ecosystem. For example, the newly introduced Superchola was genetically very similar to the Chola variety that it replaced. Unfortunately for growers, Superchola was a slow maturing potato that had become highly susceptible to late blight and insect pests. As a result, it required six to seven months of time in the field (depending on elevation and temperature) and weekly fungicide applications.

Only 50 years ago, dozens of potato varieties were consistently grown with no use of fungicides while today even the most resistant Chauchas need multiple applications. Although INIAP and CIP maintain extensive *in vitro* collections in their research stations, as field-level genetic diversity has been lost, it has become increasingly difficult for plant breeders to manage and use those collections in a manner that would benefit the long-term healthy development of potato varieties under locally changing conditions. Over the long run, if local *in vivo* genetic banks are not developed and maintained, breeders no longer would have the basic knowledge and prime materials to continue to develop resistant or high yielding varieties. The loss of biological diversity undermines human nutrition and food security (Toledo and Burlingame, 2006). From a sustainable agriculture perspective, the capacity to adapt to changes depends on the variability present in the farming system (Qualset and Shands, 2005). The loss of genetic variability brought by market-driven mono-cropping increased the vulnerability of potato crops, thus placing into risk the well-being farmers and their communities.

Soil management

Cropping intensification associated with market-oriented production further affected soil fertility. Agricultural modernisation emphasized the potato as the chief economic crop that displaced other, less marketable crops. The arrival of chemical fertilizers in the 1950s allowed farmers to intensify agriculture through closer planting distances (i.e., space) and shortened fallow periods (time). Essentially all potato farmers in Carchi use chemical fertilizers (Crissman et al., 1998; Yanggen et al., 2003). The compound fertilizer 18-46-0 (18% nitrogen (N), 46% phosphorus (P), and 0% Potassium (K)), which responded to a phosphorous tie-up characteristic of black Andean soils, by far became the most common fertiliser applied. As a result, I focused on the use of 18-46-0 since the 1970s as a proxy indicator for soil fertility.

The research team learned that 18-46-0 first arrived to the haciendas at the end of the 1950s. The first batches were German-based products. These were quickly replaced by Colombian brands in the 1960s. Cheaper, though of lesser quality, Ecuadorian products became available in the late 1980s. Prices dropped from about $1.31/kg in 1980s to $0.17/kg in 1990. Following dollarisation, the price increased to about $0.38 kg in 2000. Farmers described a marked drop in soil fertility over time, causing them to increase fertilisation applications (Figure 4.5). In 2004, farmers told the research team that they applied "one-to-one" or "two-to-one," which represented the ratio of the weight of 18-46-0 applied to potato seed planted (Table 4.2). More precise field data showed that in 2004, farmers in the four communities applied an average of 152 kg/ha of N, 359 kg/ha of P, and 161 kg/ha of K (Paredes and Sherwood database, 2004), which was about ten percent more fertiliser per area than Crissman et al. (1998) reported for the period 1990-1992. Usually they used split dressings, with about half applied at planting and the remainder applied at the moment of the first *aporque* or hilling-up of the potato crop.

During a meeting with people in Mariscal Sucre, the research team was told, "Before we produced 30 or 40 to one. Today, we are lucky to get ten to one. As a result of the overuse of chemicals, our land has become degraded and lost its fertility." Despite increased use of fertilisers, farmers complained that the potato crop no longer responded as previously. Subsequently, CIP and INIAP researchers involved with the Eco*Suelos* project confirmed what modern potato farmers had discovered on their own: continual potato production tied with the heavy use of fertilizers and pesticides in Carchi contributed to chemical and biological exhaustion of soils and long-term production declines.[26] As summarised in Chapter 2, Eco*Suelos* discarded pathogenic nematodes (*Globodera* or *Meloidogyne* spp.) as a cause of soil fatigue, most likely due to the high rates of carbofuran use. The researchers found that modern potato cultivation caused a number of indicator soilborne fungal pathogens, such as *Rhioctonia* and *Fusariums* spp., to proliferate in the system. Additionally, it appeared to have a harmful affect on beneficial organisms, especially entomopathogens (useful for keeping down Andean weevil populations) and mycorrhizae (critical for P uptake in potato). Nevertheless, funding for the Eco*Suelos* project ended before the researchers could reach more conclusive results on the biological sustainability of soil management.

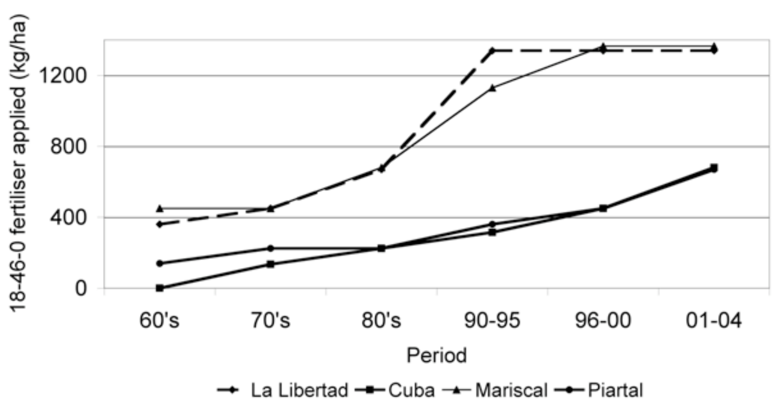

Figure 4.5 Average application rates of 18-46-0 fertiliser (kg/ha) (based on CIP-INIAP data processed through focal group sessions by Carchi Research Team, 2004)

Table 4.2 Average fertilizer applications during the 2003-2004 planting season (Paredes and Sherwood database, 2004)

Fertiliser	La Libertad (n=16)	Piartal (n=34)	Cuba (n=19)	Mariscal (n=25)	Mean	Std dev.
Nitrogen (N) (kg/h)	134.16	156.16	144.21	161.39	151.39	60.19
Phosphorus (P) (kg/h)	302.79	338.46	350.74	386.62	347.68	133.55
Potassium (K) (kg/h)	90.48	145.13	201.56	196.88	161.00	79.71

Insect and disease pests

In all four communities, the research team found that the number of pesticide applications had increased since the 1980s, despite a 250 percent increase in potato input costs since dollarisation (An, 2004). Research that took place between 1990-1992 showed that Carchi farmers applied pesticides to their potato fields an average of seven times during a cropping season, with three pesticide products in each application (Crissman et al., 1994). In 1997,

[26] Personal communication with Pedro Oyarzun, soil scientists formerly at CIP and INIAP. Also see the final report of the MAG/PROMSA supported project IQ-CV-049: "EcoSuelos: investigación para un manejo más productivo y sostenible de suelos andinos en la ecoregión centro-norte del Ecuador."

Barrera et al. (1999) also found that farmers applied seven times, with a maximum of 15. Both studies found farmers who mixed up to seven products in each application. During the 2003-2004 planting season the farmers of Mariscal Sucre employed an average of 10.6 applications of pesticides per season, followed by Cuba (7.0), Piartal (6.76), and La Libertad (4.0), for an overall average of 7.36 applications (Table 4.3). Since 1990, the Central Bank of Ecuador reports that the global sale of pesticides in Ecuador increased from about $37 million to $100 million, even though area cultivated in the country did not increase significantly during that period. When I asked the farmers why pesticide use was increasing, the group laughed and told me what had become a major feature of modern agriculture: pest problems get worse; they don't get better.

To understand historical pest dynamics, I focused on the employment of the three most common pesticides as reported in Crissman et al. (1998) and Yanggen et al. (2003): mancozeb (dithiocarbamate family of fungicides used for late blight; these represented 80% by weight of active ingredient of all fungicides applied), carbofuran (carbamate-based insecticides used for the Andean weevil and 47% of all insecticides applied), and methamidaphos (organophosphate-based insecticides used for foliar insects and 43% of all insecticides applied). During interviews and workshops in communities, our research team referred to common product names to facilitate conversations on historic application patterns.

Table 4.3 Average pesticide applications and contents during the 2003-2004 season (Paredes and Sherwood database, 2004)

Pesticide	La Libertad (n=16)	Piartal (n=34)	Cuba (n=19)	Mariscal (n=25)	Mean	Std dev.
Applications	4.0	6.76	7.0	10.6	7.36	2.92
Dithiocarbamate fungicides[a] (kg/ha)	6.47	15.20	14.46	18.69	14.49	7.34
Organophosphate insecticides[b] (l/ha)	0.72	0.87	2.32	1.94	1.42	1.25
Carbamate insecticides[c] (l/ha)	1.09	1.38	1.82	1.90	1.56	1.55

[a] largely mancozeb-based formulations
[b] largely methamidophos-based formulations
[c] largely carbofuran-based formulations

The research team found that mancozeb use had steadily increased since the early 1970s (Figure 4.6). Mancozeb was most frequently applied in the wetter climates of Mariscal and Piartal. In Mariscal, farmers increased applications from about 12 in 1970 to 14 in 2004. In Piartal farmers had increased from seven to 12. Farmers in La Libertad tended to use fewer pesticide applications overall. Paredes (in process) found that this was largely explained by their reliance on family labour. Nevertheless, in La Libertad average use of mancozeb rose from about four applications per season in the 1970s to ten in 2004. Similarly, in Cuba, mancozeb applications rose through the mid-1990s but decreased sharply after 1996, as a result of a shift towards a drier climate. In response to this trend, farmers explained that they not only increased the number of applications but also the quantity of product used (the application rate) from about one to two kg/ha (the recommended rate was 0.7 kg/100 litres of water or 1.4 to 2.0 kg/ha, depending on the stage of the crop).[27] Nevertheless, more precise data from Crissman et al. (1998) and from the 2003-2004 season showed that farmers commonly mixed commercial fungicides with the same active ingredients, thereby raising the effective application rate to 3.0 to 4.0 kg/ha. On average, farmers applied 14.50 kg/ha of dithiocarbamate fungicides (nearly all of which were mancozeb-based products) on their potato crop during the 2003-2004 season (Table 4.3). We came across farmers who applied 34 l/ha of mancozeb to their crop that season. Most farmers believed that late blight had become more resistant to fungicides, and as a result, it required both more and stronger applications. They generally increased mancozeb applications even after personal financial crisis and the doubling of prices for fungicides after 2000.

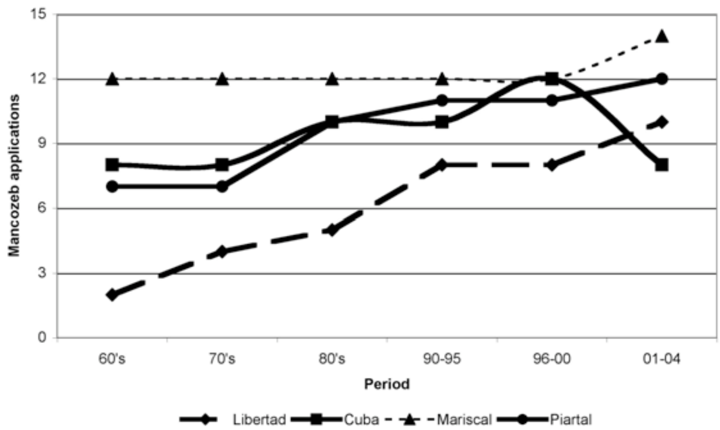

Figure 4.6 Average frequency of mancozeb applications for late blight (based on CIP-INIAP data processed through focal group sessions by Carchi Research Team, 2004)

Methamidaphos applications varied greatly within communities, but overall, the use of the insecticide had doubled since the 1970s – from about one to two applications in Cuba and La Libertad and two to four applications in Mariscal and Piartal (Figure 4.7). Similar to fungicides, application rates of methamidaphos increased from the recommended (250-500 ml/100 l)[28] to twice that in Piartal, Cuba, and La Libertad and four times the recommendation in Mariscal. On average, farmers applied a total of 1.42 l/ha of organophosphate insecticides (most of which were methamidaphos-base products) to their potato crops during the 2003-2004 season (Table 4.3). We found farmers who applied up to 8.0 l/ha of methamidaphos to their crop that season. Farmers interviewed explained that the reason was a proliferation of foliar pests, especially aphids (*Myzus pericae* and *Macrosiphun euphorbiae*) leaf flea beetle (*Epitrix* spp.), leaf miner fly (*Liriomyza huidobrensis*), and trips (*Frankliniella tuberosi*). This was a particular concern in dry years. In the case of leaf miner fly, the effects of insecticides on parasitic flies contributed to the pest's proliferation. According to one individual from Cuba, "Farmers like to see the insects fall from the sky. Then, we know we can go home and sleep at night."

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[27] Vedemécum Agrícola. 2004. División de Publicaciones Técnicas, EDIFORM, Quito, Ecuador.
[28] Ibid.

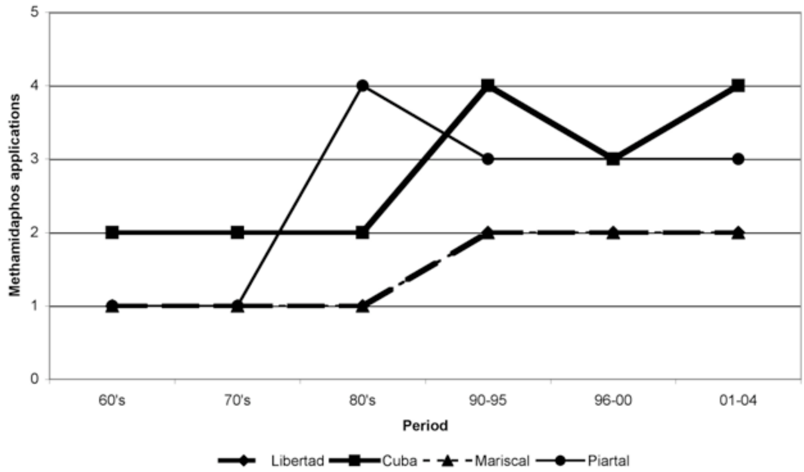

Figure 4.7 Average frequency of methamidaphos applications for foliar insects (based on CIP-INIAP data processed through focal group sessions by Carchi Research Team, 2004)

The number of carbofuran applications for the Andean weevil varied greatly (Figure 4.8). Overall, since the 1970s farmers increased applications by a factor of two or four. The manufacturer recommended one to two applications (at planting and hilling),[29] while previously INIAP recommended a maximum of one application.[30] On average, farmers applied a total of 1.56 l/ha of carbamate insecticides (nearly all of which were carbofuran-base products) to their potato crops during the 2003-2004 season (Table 4.3). We commonly came across farmers who applied up to 12 l/ha of carbamates that season.

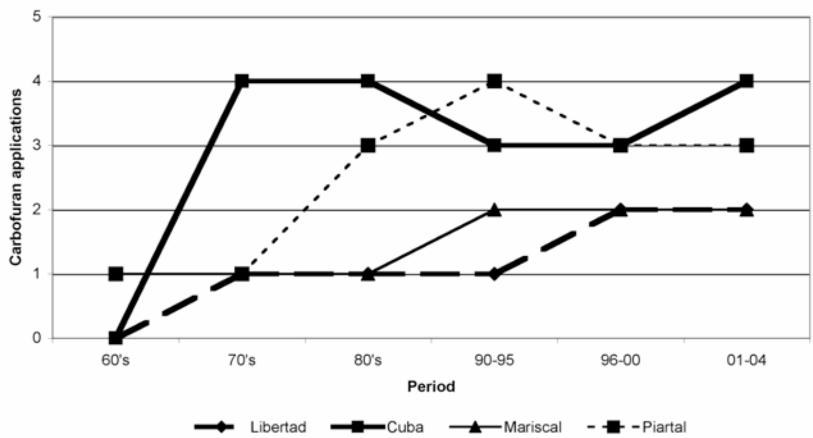

Figure 4.8 Average frequency of carbofuran applications for Andean weevil (based on CIP-INIAP data processed through focal group sessions by Carchi Research Team, 2004)

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[29] Ibid.

[30] In large part due to the joint INIAP-CIP research in Carchi, in 2002 INIAP's potato program stopped recommending highly toxic pesticides.

Farmers explained that previously, they produced potato with little to no weevil damage. Likely, the pest was controlled through numerous small plots, spacing between fields, and length of fallow season. As the size of potato fields grew and fallow seasons shortened, Andean weevil populations exploded, converting from a secondary insect to a major pest. Additionally, many farmers believed that the weevil had developed resistance to insecticides, so they needed to apply stronger rates.

Patricio, a medium-scale potato farmer and former pesticide salesman from San Gabriel, summed up the modern pest problem: "If the *gusanos* [or worms] choose your crop, they win, hands down. No *Ingeniero* or God can help you." He went on to tell what had become a familiar story: agricultural intensification in Carchi did not just lead to increases in potato production; it also produced soil degradation and a proliferation of pests. Most farmers said they generally were aware of the health problems associated with pesticide use. Nevertheless, modern time had introduced them to a new reality: the only thing worse than using pesticides was not using pesticides. They applied more and more fungicides and insecticides and used heavier application rates, but they still could not win against the pests. Resorting to pesticides was the best they could do to keep their crops alive and eke out a living, with the hope of someday being able to pay off their climbing debts. The only other option was to sell off land and animals and move to the city. Patricio concluded, "Pesticides permit us to live, so that we can plant another day."

Economic performance

While processes of market integration in Mariscal and Piartal started in the 1930s and 1950s, respectively, farmers there did not grow large quantities of potato for sale until after agrarian reform – about the same time that farmers in Cuba and La Libertad shifted towards commercial production. Previously, the farmers of Mariscal and Piartal met their debt payments primarily through wood harvesting and charcoal production. For the purposes of this research, I focused on economic trends in potato production since the late 1960s and early 1970s. Particularly, I examined global tendencies in production by area, production costs, prices, and productivity.

a) Production by area

In all four communities, farmers said that adoption of mechanized tillage, fertilizer and pesticide technologies led to sharp increases in production during the 1970 and much of the 1980s, followed by slow but steady declines during ensuing decades (Figure 4.9). Despite steady increases in fertilizer use, the land no longer responded. The most drastic decline took place in Cuba, where in 1970, harvests reached 55 t/ha, but by the early 1990s, production decreased to about 16 t/ha. When I asked why, I was told that first, the soil had become "tired," then the pests came, and finally, the weather changed. While I did not have precise weather data for Cuba, farmers emphatically argued that since the early 1990s, rainfall had declined and the monthly distribution of rainfall was less predictable than previously.

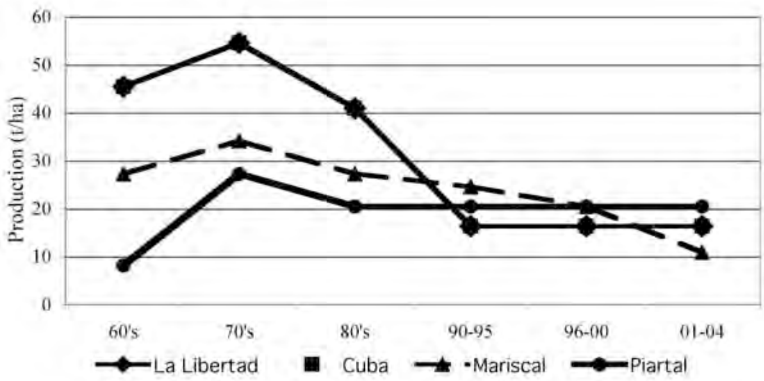

Figure 4.9 Average potato yields by area (based on CIP-INIAP data processed through focal group sessions by Carchi Research Team, 2004)

While initially there were dramatic differences in production by area among the case study sites, differences reduced during the 1980s. Based on high quality, dynamic data from 1990-1992, Crissman et al. (1998) found an average production of 21 t/ha. Based on interview data from 1997, which followed a particularly dry *El Niño* year, Barrera et al. (1999) reported average production of 16 t/ha. The 94 farmers who participated in our 2003-2004 data collection produced an average of 15 t/ha during a season with normal climatic patterns, with average yields for communities varying between 12 and 18 t/ha. Combined, these studies generally support what we heard during 2003-2004 – potato farmers of Carchi experienced a sharp decline in production between the mid-1980s and the end of the 1990s.

b) Production costs

Despite global potato production declines over the last several decades, farmers in Carchi continue to produce two to three times the national average.[31] Nevertheless, farmers there also have the highest production costs in the country. Since the mid-1980s, production costs have increased steadily, with a sharp increase in the early 1990s due to the elimination of government price controls on agrochemicals in 1992, followed by a policy shift in 1993 towards active management of currency exchange and steady decline in the real-effective exchange rate of the Sucre (Lee and Espinosa, 1998; Beckerman, 2002) (Figure 4.10). As a result, production costs rose sharply from about $250/ha in 1990 to $1,500/ha in 1993 (Crissman et al., 1998).

During the 1990s, labour represented about 25 percent of production costs in Carchi and external inputs about 75 percent (Crissman et al., 1998; Herrera et al., 1999). According to Herrera et al. (1999), fluctuations in real input costs generally explain the variations in potato production costs between 1989-1998. Input costs rose faster than labour due to revaluations of the Sucre in the early 1990s and the fact that essentially all agrochemicals used in Carchi were imported. Between 1997 and 1998, Ecuador experienced an economic

[31] INEC, 2004.

crisis and spontaneous dollarisation that doubled the real-effective exchange rate of the Sucre, leading to a temporary drop in production costs and tremendous windfall profits for producers that levelled off following official dollarisation of the economy in 2000 (Beckerman, 2002). Since that time, input costs increased steadily as a result of the inflation associated with dollarisation. In 2004, Paredes and I found potato production costs in Carchi at above $2,000/ha.

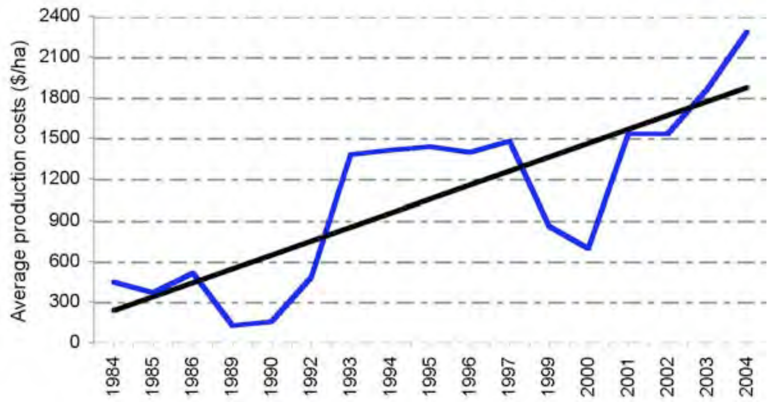

Figure 4.10 Potato production costs in Carchi (1984-2004) (*Banco Nacional de Fomento* and INIAP UVTT-Carchi data)

c) Prices

Generally, potato prices in Ecuador are inversely related to the available supply of the commodity (Figure 4.11). The supply of potato in the country is largely a function of aggregated production as a result of climate, soil fertility, and pest management rather than market demand for the crop (Herrera et al., 1999). Potato production has low market elasticity; only about 18 percent of production behaviour can be explained by market price. Location on the equator and the diverse environmental niches of the inter-Andean valley mean that farmers at different locations continually plant and harvest. Volatile weather conditions common to highland environments contribute unexpected periods of rainfall, drought and frost, with associated effects on insect pests and plant diseases, especially of devastating pests such as the Guatemalan potato moth and late blight. Additionally, since the environment in the Northern Andes permits continual production, varieties have not been selected for storage. Four to six weeks after harvest, potatoes turn green, so they must be sold right away. The inability to store potatoes until prices improve increases farmer vulnerability. The combined effects of environment, climate, pests, and lack of storability lead to highly unpredictable commodity supply. As a result, prices fluctuate tremendously, making potato production a high-risk enterprise.

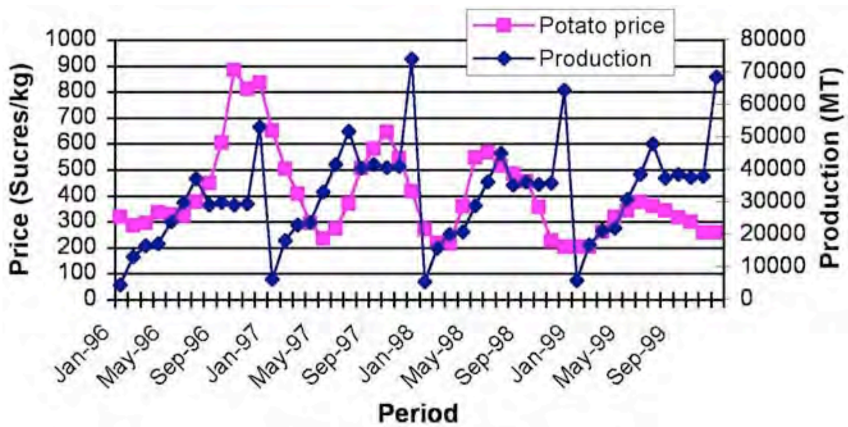

Figure 4.11 Variability of potato price with production (MAG and Central Bank of Ecuador data, as reported in An, 2004)

Figure 4.12 presents minimum and maximum prices for the varieties Chola and Gabriel at the Quito wholesale market between the period of 1990 and 2004. The two varieties show similar patterns of variability, with Chola consistently presenting higher prices at both peaks and nadirs. While minimum prices were relatively stable between years, varying by about 50 percent, maximums commonly varied by over 300 percent. In 1996, *El Niño* led to severe drought in the highlands. Price increases between 2000 and 2002 were due to inflation associated with the process of dollarisation. Meanwhile, the data on monthly prices for Chola at the Quito wholesale market provide greater resolution on the drama of price variability (Figure 4.13). With the exception of the 1996 *El Niño*, the bulk of variation in price occurs within years, with little to no perceptible pattern across the months. During 2002 and 2003, average yearly potato prices tended to decline. Nevertheless, during that same period, monthly prices occasionally peaked and crashed to historic levels. During the 1990s monthly prices fluctuated by a factor of three to six. Since dollarisation, prices have fluctuated from $0.80 to $20 per quintal, an astounding factor of 25 (Paredes, 2001; An, 2004)! The odds of harvesting at a highpoint in market demand indeed were comparable to "winning the lottery."

In a study of price differences among producers, wholesalers and consumers between 1990 and 1998, Herrera et al. (1999) found that producer prices had decreased disproportionately. While relative potato prices increased with inflation for wholesalers and consumers, as of 1995, real prices for producers dropped by about 30 percent, a relationship that continued through 2004. The potato region with the lowest prices for producers was Northern Ecuador. The odds of losing in potato production, especially in Carchi, had gone up.

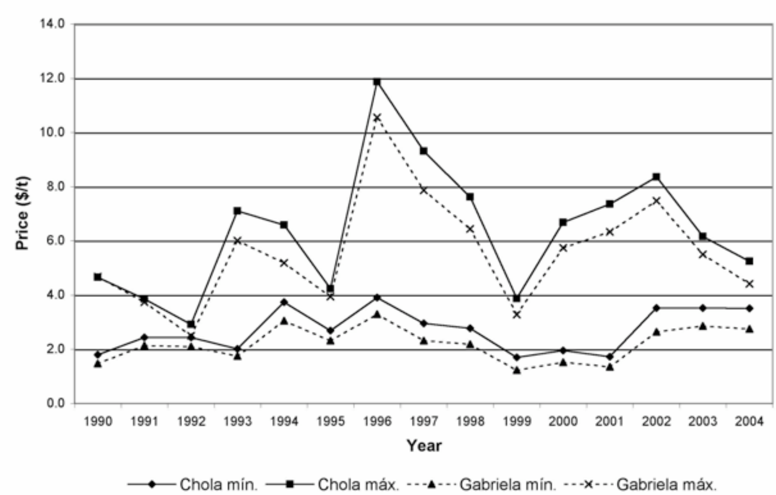

Figure 4.12 Extreme monthly potato prices for Chola and Gabriela between 1990 and 2004 (wholesale market, Quito) (MAG and Central Bank of Ecuador data)

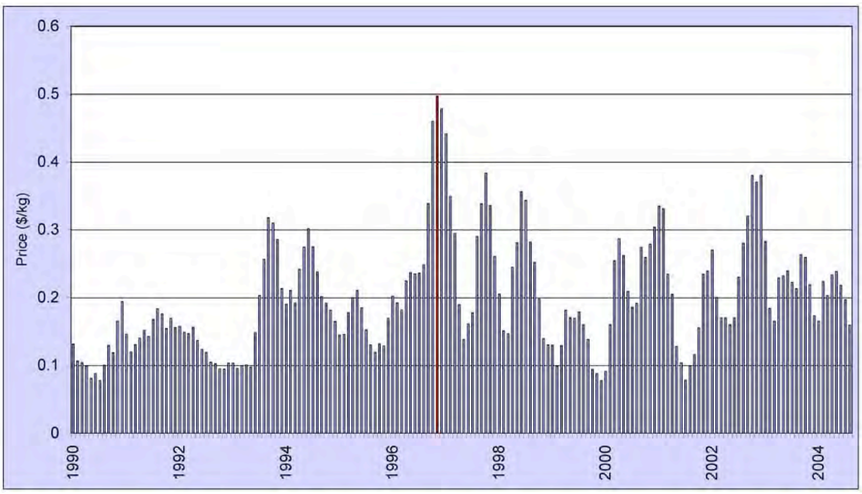

Figure 4.13 Monthly variation in prices for Chola (1990-2004) (Quito wholesale market) (MAG and Central Bank of Ecuador data)

d) Productivity

We did not find reliable yearly data on productivity for the 1970s, but the fact that farmers managed to quickly pay off their debts associated with land acquisition and substantially increase area planted suggested they did well during that period. Barsky (1984) found that between agrarian reform and the mid-1970s production increased by about 40 percent and worker productivity by 33 percent. In contrast, INIAP's data showed that potato productivity in Carchi steadily declined since the mid-1980s (Figure 4.14). When the research team shared this data with farmers in the four communities, they concurred, explaining that in the 1970s and 1980s soils were more fertile and pests less problematic, allowing them to use less agrochemicals. Additionally, in those days prices were relatively high and stable. The farmers explained that their prosperity began to change in the early 1990s. They experienced a series of average to bad years combined with an increase in fertilizer and pesticide costs. Lee and Espinosa (1998) explained that the rise in input prices during the early 1990s was due to a sharp decline in the effective role of tariff exemptions for agricultural inputs. The farmers at our research sites questioned the INIAP data showing positive productivity after 2001. Consistent with the findings of An (2004), following dollarisation of the Sucre in 2000, *Carchense* farmers experienced increases in input prices and labour costs of more than 200 percent, which negatively influenced the productivity of potato farming.

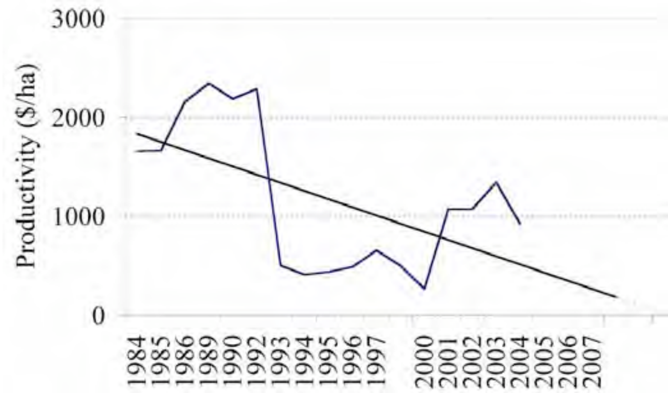

Figure 4.14 Productivity of potato production in Carchi (INIAP UVTT-Carchi)

Beginning in the 1990s, Carchense farmers increasingly lost money on potatoes. Based on data from 1990-1992, Crissman et al. (1998) found that farmers in Carchi produced on average 21 t/ha, but they lost money on 43 percent of the potato fields they planted. During the 2003-2004 season, which farmers classified as a good year, Paredes and I found that farmers produced an average of 15 t/ha and lost money on 55 percent of their potato crops (Table 4.4). The empirical evidence of production decline and overall production failures was overwhelming, especially for certain styles of farming. For example, Don Brocardo was famous in Mariscal for betting everything he had on his potato crop. According to Paredes' (2001 and in process) classification of farming styles, Don Brocardo was a clear example of a "high risk taker," the most prestigious group of farmers in Carchi. When we visited him in 2004, he had just lost his vehicle, house, and land to mounting debts, which made him the talk of the town. According to Don Brocardo and the farmers we consulted, the problem was not potato production but rather prices, especially price variability. Don Brocardo fell into debt not because of field production but because he harvested when prices were low. Three losses in a row led him to financial collapse and the loss of his land. In sharp contrast to the successes of potato farmers in Carchi during the 1970s and 1980s, Paredes and I found that the dramatic failures at the market place since the early 1990s were becoming legendary.

Table 4.4 Average yield, net revenue, and farmers who lost money on their potato crop during the 2003-2004 season (Paredes and Sherwood, 2004)[a]

Community	Average yield (t/ha)	Average net revenue ($/ha)	Farmers losing money (% total)
La Libertad (n=16)	17.99	690	31
Piartal (n=34)	13.73	148	59
Cuba (n=19)	12.36	-559	89
Mariscal (n=25)	15.35	534	40
Average	14.86	203	55

[a] For comparison purposes, Paredes and I employed cost-benefit methodology consistent with that used in Crissman et al. (1998).

Modernisation: motor of wealth, motor of decline

In summary, performance of agricultural modernisation in Carchi followed a general pattern of a sharp rise followed by steady decline. The first communal harvests on degraded ex-hacienda soils were low at about 10:1, meaning that for each sack of potatoes planted, they harvested ten sacks, which was about 14 t/ha. During the early 1970s, State extensionists arrived to offer in-kind loans in the form of sacks of fertilizers and later, new varieties and pesticides that had to be paid back in cash. Initial use of agrochemicals led to sharp increases in production, so, after paying off debts, farmers were left with surplus cash for the first time in their lives. The research team found that fertilizers led to an immediate increase in production, often to a ratio of 30:1 (41 t/ha). The *técnicos* from MAG and INIAP advised them to shorten planting distances from about 1.40 m between rows to 1.00 m, which further contributed to production by area.

The early success of modernisation spread through communities like "wildfire." The beneficiaries of agrarian reform built permanent houses, and entire families moved onto the communal land. Area under potato cultivation multiplied by a factor of five. While variable, potato prices were generally strong during the 1970s and the first half of the 1980s, enabling a large number of farmers to "hit the lottery." This enabled them to pay off debts and to accumulate wealth, often in the form of a truck or the purchase of additional land.

Diverse success stories were present in each community and were widely known, inspiring an entire generation of farmers to go further into debt so that they could afford the use of greater quantities of agrochemicals. The farmers who invested most – the "high risk-takers" – became an admired and highly regarded social group. Farmers generally sought to maximize area planted to potato. They increasingly converted pasture, forests, and páramo to the crop. Fertilizers enabled them to more intensively plant potatoes, and production by area climbed to over 50 t/ha.

After ten or 15 years of accumulation, potato crops began to fail. Soils became tired, pests were more problematic, and potato production grew to be dependent on greater and more intensive use of agrochemicals. Meanwhile commodity prices became more variable, moving towards an overall tendency of decline. At the same time, the government dollarised the economy and input prices nearly tripled. As production failures became ever more common and debts mounted, the odds of "winning the lottery" became insurmountable. Over thirty years, the products of agricultural modernisation made potato production an increasingly expensive and risky enterprise. In 2004, more and more rural families found themselves in dire economic straits, causing them to abandon not only potato production, but agriculture. For a growing number of rural families, the model of agricultural modernisation had reached a state of collapse.

Social transformations

What were the influences of agricultural modernisation on people and their communities? Following individual and group interviews on technical transformations, the research team moved on to conduct interviews with individuals and small groups of people in each community to learn how life had changed since agrarian reform. In 2004, the Carchi Research Team interviewed individuals in each community followed by larger community-level meetings at the case study sites. It employed a common series of questions on the source of rural change, role of rural peasants in production and society, relationships between peasants and authority, sources and flows of knowledge and technology, livelihood strategies, and moments of collective organisation. While there was much discussion over terminology and dates of events, participants had little difficulty reaching consensus on four general "critical moments" of transition in Carchi: the "hacienda," "land distribution," "technification and market integration," and most recently "dollarisation." The synthesised results appear in Table 4.5. In continuation, I provide a summary description for each period.

Hacienda period: "era of the patron*"*

In Mariscal Sucre and San Pedro de Piartal (villages that managed to purchase land well before agrarian reform), we found mixed emotions about the hacienda period. The present-day population of people who worked in the hacienda was low. Most people arrived following land purchase and either owned their own land since arrival or worked as *jornaleros*. These people were less dependent on the hacienda for their livelihood in the past. We were surprised to learn that parents and grandparents commonly had not told the youths about the difficulties on the hacienda. A father told me, "Why should we teach our children to hate?" The youth and the *colonos* or colonists tended to romanticize the hacienda time, saying for example, "Before we did not need to worry about our health. We did not need to go to see the doctor; we could cure ourselves with plants." "There was greater interest in religious matters. People were more spiritual." These comments provoked controversy. While many of the people who did live under the hacienda in Mariscal generally admired the *patrón* of the El Salado Hacienda, the people of Piartal who lived under the Indujel Hacienda had a very different experience. A woman from Piartal said, "In those [hacienda] days we suffered incredible poverty. Sometimes we went days without food to eat. In those days, not even the Government was around to help. The Government

Table 4.5 Summary descriptions of critical periods of modern agrarian change in Carchi

Criteria	Hacienda – "era of patron"	Land – "free at last"	The market – "the risk-taker"	Dollarisation – "period of crisis"
What is the source of change?	Hacienda	State	State	Market
What is the dominant pattern of authority (authoritarian, paternalistic, democratic)?	Authoritarian or paternalistic *patrón* (depending on *patrón*) – rigid or friendly control, but top-down	Paternalistic State – help the poor farmers with land and credit	Paternalistic State and *técnico* – help for the poor farmers with technologies.	Paternalistic politicians – help the poor farmers; pacify with gifts, especially during election years
How does authority view farmers?	Peasants – passive agents that need supervision and control	Generally irresponsible peasant farmers – need State's care and supervision	Generally irresponsible farmers or producers – need State's care and technologies	Generally irresponsible producers – need State's care; need help to be competitive or to be given things
What is the primary role of farmers in society?	Follow orders and work	Work – civilize land and plant crops to pay back State	Produce and consume – buy products and produce so that you can pay for them	Go into debt and consume – buy increasingly expensive products and try to survive
How do farmers perceive authority (fear, gratitude, trust, or distrust)?	Fear or gratitude – *patrón* is all powerful and deserves respect	Gratitude –State is concerned about us and knows what is better for us	Gratitude –State and its *técnicos* are concerned about us and know what is better for us	Distrust –State is corrupt and exploits us; rich control markets
From where does knowledge and technologies come?	*Patrón*	State	*Técnicos*	Market or private companies
What do farmers need to know to be successful?	• How to obey *patrón* • How to work hard • Obedience • Rules	• How to obey State • How to work hard • Obedience • Rules	• How to exploit services of State and NGOs • How to manage pesticides and fertilizers • How to produce • How to win lottery	• How to exploit municipality and private industry • Integrated Crop Management • How to compete in unstable, lower value markets • Friends in the city who can employ children
How does knowledge flow?	From *patrón* to administrator to peasants	From the State to farmers	From *técnicos* to farmers; among farmers themselves	From market and industry to farmers
What is the principal livelihood strategy?	Win confidence of *patrón*	Make land produce; pay off debts	Adopt technologies and win lottery	Avoid debt; educate kids; migrate
When do people organize collectively?	According to needs of *patrón*	To obtain lands and receive loans	In *mingas*, to build and maintain infrastructure	To protest; "We no longer organize."

did not care because we were still living under the *conquista*." Another woman added, "The [hacienda] period was the epoch of slavery. The workers were the slaves of the owners and administrators." A man added, "We suffered a lot. My childhood was very sad. All we did was work for the *patrón*, and then later, we worked to pay off our land, harvesting charcoal and selling firewood."

In Cuba and La Libertad (villages that obtained land through relatively violent processes of social organisation and confrontation), we also found mixed emotions about the hacienda period. In each community, people made similar points: "The patrón provided work, a house, food in some cases, and education for your children through fourth grade." "In those days we believed in God. We were *endiosados* [or blessed by God]." "There was forest and water, and the land gave us everything we needed." "As youth we had our strength; be it good or bad, at least we were strong." After hearing these comments, the elderly stepped up to remind the group of certain harsh realities of that period. "The youth of today has never known hunger." "I was beaten and placed in jail because I was too sick to work one day. We watched *compañeros* die under the whip." "We were slaves to the *patrón* and the *mayordomo*. The *peones* enjoyed a degree of security, but the *jornaleros* lived day-to-day." "All we ever dreamed about was having our own little bit of land." "All we wanted was a place for our children to live and work without having to pay rent."

In summary, communities remembered the hacienda period diversely. The opinions of those who lived through it were shaped by relationships with the *patrón*. There was a general impression that the natural environment – the forest, water, and land – was more intact and abundant. Compared to modern time, during the hacienda period people were more religious and respectful of authority. Nevertheless, the elderly reminded us that it was a period of social domination where wealth and prosperity lay in the hands of the few and the majority – the workers – lived as servants. Their role was to conform to the situation and accept the authority and will of the *patrón*, to follow orders and work. This produced fear in some and gratitude in others. As society was organised, the well-being and destiny of the rural peasant was placed in the hands of another. Nevertheless, through hard work and obedience, a peasant could win over the confidence of his or her *patrón* and be guaranteed a roof, food, and security.

Land distribution: "free at last"

The experience of obtaining land was less controversial than the hacienda period. The communities of Mariscal and Piartal acquired land through "colonisation," which involved collective organisation and peaceful purchase from the haciendas. Cuba and Libertad obtained land by forced take-over, followed by government intervention and adjudication under the agrarian reform law. In all cases, peasant farmers found "land distribution" a period of unprecedented achievement and hope.

In Mariscal a farmer proudly said, "We were united poor. The *mingas* [i.e., collective work parties] were a preponderant factor rooted in the mind and the heart of the *Huaqueño*. Los *Huaqueños* were the winners of the *mingas* of the road between Ibarra and Tulcán. They worked night and day, and their women worked just as hard." The people of Mariscal and

Piartal made multiple references to the construction of the Pan-American Highway as a moment of inspiration (Box 4.2).

Don Clodomiro Aguilar [the leader of the colonisation in Mariscal] said, the voice of God could not contradict him. He meant that colonisation was the only alternative for escaping our situation. We learned that we were good farmers – we were capable of earning money and employing people." "Between the 50s and 70s we were *minqueros de excelencia*." Farmers emphasized that they were groundbreakers; they did not receive government assistance or credit. In Mariscal, if we wanted something, we organised and worked for it. The people of Mariscal had achieved land and prosperity through "initiative, sweat, and tears," decades before land reform.

The people of Piartal told the research team, "We paid for the land with pure force of work. We wove *panchos* in workshops, cloths of wool, fine straw hats. The work in the mountains to obtain charcoal was extremely hard." Another person added, "Before we did everything in groups. We brought together money through the force of work, for example, when we obtained land or built the roads. This produced value in a person's word, honour, and solidarity. In those days, these values were very strong."

Not all people, however, were immediately ready to "liberate" themselves from the hacienda. One farmer from Cuba remembered fearing the event of separation from his *patrón*: "The illusion emerged from the mind of the very *patrón* – that we would be better off on our own, abandoned by the patrón. He proposed that we should create a pre-cooperative so that we could own one of his mountains. Many of us were not so sure. I did not sleep at night." As a result of such concern, Cuba's first attempt of establishing a cooperative in the mid-1950s failed.

Similar to their colleagues from Mariscal and Piartal, many farmers of Cuba and La Libertad dreamed of "owning land where we could plant, liberate ourselves, and not work until we became ill." Nevertheless, the colonists from Mariscal and Piartal sometimes looked down upon communities that ended up receiving land through agrarian reform: "The people from Huaca said [of the people from Cuba], the communists have arrived there; only communist take land by force. But, we did not feel like communists." "We were honest, hard-working people. We valued hard work and the great effort it took to meet debt payments; it was a great value to work organised [in groups]." In Cuba the great "illusion" or aspiration was to work together. "Everyone planted in union. We worked [together] three days each week. Everything we had, we planted. The credit was collective. We all would make it ahead, or we would all sink together." In all four communities, the cooperatives paid off their debts on time.

In summary, for the smallholder farmers of Carchi the period of land distribution brought a fundamental change to their lives, and it symbolised an era of great hope. For the first time, peasant farmers felt as though they had become a part of broader society – a feat beyond the dreams of their parents and grandparents. The State existed, and it supported them in the form of the Agrarian Reform Law, IERAC, *Banco de Fomento*, and MAG. The legal system defended their interests. At the time, they felt truly liberated, in the sense that

Box 4.2 Construction of the Pan-American Highway in Carchi (Carlos Raza-Salcedo, nd, as summarized in M. Landázuri, 2003 and C. Landázuri, 2003)

Through the end of the 1920s the Province of Carchi was isolated from the rest of Ecuador. A trip between San Gabriel and Quito took about five days by horseback and other precarious means of travel. As a result, the people of Carchi had greater business and social interactions with the nearby city of Ipiales, Colombia than with the rest of Ecuador. Following a workers protest in 1925 that became known as the "*Revolución Juliana*," the government decided to build a road between the city of Ibarra and the Rumichaca River on the Colombian border. It studied three routes across the highlands of Carchi and chose the shortest western flank of the Andes, which would pass through Chota, El Angel, and the unpopulated *páramo* to Las Juntas and finally to the border city of Tulcán. While this western route represented the seemingly most economical option, the communities along the eastern alternative – Bolivar, La Paz, Sand Gabriel, Cristóbal Colón, Dacha, and Julio Andrade – decided to change the calculus.

While the government continued with the western highway, the people of Montúfar had decided to build an eastern highway on their own. Led by Manuel J. Bastidas, an eccentric farmer-researcher famous for his improvement of potato varieties and cattle, the able people of the villages of Montúfar united and on 25 September 1927 brought their picks and shovels with them to the main square of San Gabriel. Creating the "Pro-western highway Committee," they took charge of tracing the route of the road, which included negotiations with the landowners, provision of tools, and obtaining horses for transporting rocks and logs. Additionally, they had to organize food, housing, and other logistical support for what would quickly become thousands. The first three-day *minga* took place between 25-27 September and involved 6,250 men, plus hundreds of women and children who prepared food, transported water, and provided other logistical support. By the afternoon of 27 September, a stretch of highway running North across the inter-Andean Valley and measuring some forty kilometres was opened. That same afternoon the first automobile arrived to San Gabriel from the city of Pasto, Colombia. This early success inspired them to look South.

The highway to Ibarra posed greater challenges due to the difficult rocky and mountainous terrain. On 25-27 September 1930, a work party of some 15,000 volunteers, now from both Carchi and Imbabura, arrived to the banks of the Chota River, across from the town of Juncal, Imbabura. Over three years, the people of Northern Ecuador had opened over 100 kilometres of road. Impressed by the enormity of this effort, the government ceded and financed the construction of the bridges as well as the repair of certain problematic sections that would take through October 1936 to finalize. In honour of this effort, in 1934, the Ecuadorian Congress awarded the industrious people of Montúfar, for the first and only time in the country's history, the "National Distinction of work." Today, in the plaza where the decision was made to build what has become the northern stretch of the Pan-American Highway, stands a statue of a nude man with a pick and shovel – the anonymous worker and hero of Carchi.

they had greater control over their destinies. Their role was to “civilize the land” and make it productive so that the cities could eat. They also needed to make money so that they could pay back their loans and demonstrate that they were responsible people, which they did. In all four cases, the farmers felt that they had benefited from the acquisition of land, and they were eager to become modern, which involved producing for the market and adopting new technologies.

Technification and market-oriented production: “era of the risk-taker”

> I have the vice of planting. Over the years, it has taken everything. We began with nothing, but later we made it to just a few steps short of indigence. I don't know if you have a vice, but I have only one... I am not a drug addict, I don't smoke, but yes, I have one major vice: I like to plant. – Patricio, a “high risk-taker” from San Gabriel

Alfonso, from Cuba, told the research team that during the days of land distribution, “We believed that the land could produce on its own. All it needed was work and intelligence.” With the arrival of *técnicos* and modern technologies, they were taught that these resources were not enough. In Cuba and La Libertad the government-supported land credit was conditioned with “technification.” Barsky (1981) explains that technification was part of a government-led policy of “agricultural modernisation” in Ecuador built on a model of “technology generation and transfer.” The model involved MAG- and INIAP-supported “technical assistance” for specialised market-oriented production and the adoption of new varieties and agro-chemicals. The research team learned that during agrarian reform the different cooperatives in Carchi gained access to tractors, certified seed, fertilizers, and pesticides. Victor from Cuba explained, “A group of *gringos* from 4-H and *ingenieros* from MAG came to tell us how to plant like modern farmers, but we learned almost everything we know from other *compañeros*.” A colleague added, “Later, in 1977, there were more courses, but they were only for the Catholics.” Regardless, once they gained access to the new technologies, most of the learning came through empirical experience and informal farmer-to-farmer communication.

In order to pay off land and product debts, the new farmers had to earn currency, which meant entering the markets. Similar to their predecessors in Mariscal and Piartal, the cooperative in Cuba decided to "convert the forest to cash" as a means of paying off the better part of its land debt. They organised collective work parties to cut down remaining outcroppings and reduce the wood to *carbón* that was sold in San Gabriel and Tulcán. Additionally, they pooled resources and planted in communal plots. "The people were very united and got together to work, play sports, talk or rotate guard duty. *Mingas* were very common, often every week, and people were willing to help with anything." In Cuba, Victor told the research team, “We worked [in groups] three days a week until we planted everything we had. We selected Juan Cuespud as our Administrator. He managed the money and negotiated with the buyers who came to the fields at harvest time to get drunk and pick up their *quintales*. In those days, no one risked taking out credit on his own.”

At all four locations the cooperatives paid off their debts on time. In La Libertad, the research team was told, "We, as rural people, like to be honourable. They [the government] did not forgive our debt. Instead, they came to complain. They said to us, 'You have to pay your debt. If you don't, its robbery.'" Later, individual members, especially the "opportunists" (those who were not farmers but arrived from outside to take part in land acquisition), decided that they wanted control over their own parcel of land. Sometimes members wanted to sell out and move to the city, but mostly they wanted access to credit for technology, and the banks demanded land titles as collateral. After paying off the land, the cooperatives in each village eventually divided up the land among members by lottery.

While members were open to giving people land titles and allowing some to sell their plots, they did not necessarily want the cooperatives to disband. A man from Cuba said, "Our great error for the end of the organization was when the people began to sell. They did not respect the land as belonging to the community. They sold as if the land was theirs." Humberto from La Libertad said, "We all paid our debts at the first opportunity. Later, each member [of the cooperative] started to take out credit for himself. This is what destroyed the 23 [the *Cooperativa 23 de julio*]."

Barsky (1984) describes that immediately following land acquisition, rural Carchi experienced the spontaneous spread of industrial era technologies and market integration. As a result of new revenues from the oil boom, the Ecuadorian government invested in the transportation and communication infrastructure of the province, which further fuelled this development. Contrary to popular view of farmers as conservative actors resistant to change, the people of Carchi demonstrated remarkable adaptive capacity. They generally accepted everything that the *técnicos* and government asked of them. Barsky estimated that within five years 70 percent of villages had reorganised around the market. Within a decade, essentially the entire rural population of rural Carchi shifted to intensive potato production built on externally sourced knowledge, technology, and debt.

Paredes' research (2001 and in process) found that by the mid-1980s the most respected and admired farmers in Carchi became the ones who "bet it all." These were cavalier individuals who planted in large scale and over-extended themselves with external technology and credit to the point of great financial risk. Patricio from San Gabriel was an example: "I don't plant small areas, I plant big areas – six hectares in one shot. I want to feel alive. If I do well, then I will feel reborn. If I fail, I also want to feel that. There's nothing like failing for making you feel alive." These were the "true" potato farmers – the people who determined local meanings of "good farming" and pioneered technological development. The era of technification produced a transformation of potato production as well as new farming style of great prestige: the "high risk-takers."

Dollarisation: "period of crisis"

When I first heard people in Carchi speak of "dollarisation," I understood it in purely economic terms. "Our money [the Sucre] of before was better. Today, a dollar is not worth anything; it does not buy a thing. The country has become poorer with dollarisation." Dollarisation of the Ecuadorian Sucre was tied to the banking crisis (Beckerman, 2002).

Nineteen of 25 national banks had been closed in 1999, causing people to lose confidence in financial institutions. A woman from Piartal highlighted a common sentiment: "Our cows have become our bank; our *cuy* [guinea pigs] and chickens our money boxes."[32] Converting from the Sucre to the dollar was difficult. What one day valued S25,000, the next day valued just $1. Beyond the problems of rounding off currency fractions, prices in dollars started to climb. Between 1999 and 2003, inflation for many items that rural people purchased was about 250 percent. Poverty in the country climbed by over 20 percent, with the great majority of that occurring in rural areas. The banking crisis combined with dollarisation of the Sucre caused 3.5 million people, most from rural areas, to abandon their families and communities and migrate to foreign lands. By any standards, it was a difficult period.

The economic crisis certainly was part of dollarisation, but people explained that the crises went deeper. Thirty years of intensification introduced new social and environmental problems. The research team heard many stories about fragmentation between people and the land as well as among people themselves. Victor, from Cuba, explained, "Today, there is no way to organise ourselves, since no one has time. Each person looks after his own interests. Now, it's the market that gives us orders. A farmer in Piartal confided that as a result of dollarisation, "Our land and our agriculture escaped from our hands." Land distribution and market integration brought success beyond dreams, but it also brought a quick end to an early project of collectivisation.

A mother in Mariscal told the research team, "The dollarisation has meant the degeneration of our youth." According to a couple in Cuba, "All our children want is a cell phone and a one-way bus ticket to the city. All we want for our children is that they leave, so they don't have to suffer as we have." I responded, "But parents always have complained about the crazy ways of youth. I know I made my parents suffer." The mother corrected me with a lengthy argument about how things were different now. Life had "accelerated," she said, kids grew up rapidly and were vulnerable to distant influences. They used foreign words, dressed in weird clothing, and listened to strange music. Youth no longer wanted to work in the fields. Some children, she confided, had become so frustrated with life that they went off to join the guerrilla groups in Colombia – a delicate topic that everyone knew but that was rarely brought up in conversations, especially with a *gringo* in the room. "Forget about them going to church," she said. The best thing that a parent could hope for, she repeated, was that their children someday would go off to study in the city and never look back.

Additionally, many farmers described a "loss of control" over agriculture. Farming was always a risky enterprise, but now it had become more so. In the fields, crises were no longer seasonal but weekly, if not daily. Now pest outbreaks seemed to come from all sides – from the sky, neighbours' fields, the seeds, and the soil. Pesticides continued to offer relief, but they also began to realise the new problems associated with pesticides, such as continual dizziness, headaches, and nausea, as well as the fear that they were not going to be able to meet debt payments, which would place into question their honour as *campesinos*. While prices were always a problem, fluctuations had accelerated. Peaks inspired families to

[32] Quoted in Mera-Orcés, 2000: 15.

plant more, and nadirs carried them further into debt. Even the weather seemed more severe. Droughts arrived in the middle of the growing season, and when rainfall came, it was violent and accompanied by floods and hailstorms that destroyed crops. Look across the hillsides, Alfonso told me, and you won't see any potatoes planted. That was not because they did not want to work, he explained, it was because they did not have the money to plant. Alfonso said, "We are living off the cows, but the pasture cannot pay our bills." The success stories of the past had been supplanted by stories of failure. Increasingly, farmers were selling off their land. Once proud farmers had become landless *jornaleros*. Others had moved to the city.

Some farmers blamed themselves for their situation: "We are *brutos*. They gave us the land, and we destroyed it. Now, we are all going to have to migrate to the cities." Others expressed resentment towards different forms of authority. With the banking crisis and dollarisation of the Sucre, many no longer felt that the State represented their interests. In November 2003, thousands of farmers descended on the Pan-American Highway in protest over everything – from the economic situation, the cost of inputs, market prices, to the government support of the Free-Trade Agreement.[33] According to the Sub-secretary of MAG who was assigned the task of ending the strike, "They seemed to be angry about everything."[34] Such sentiment had grown common throughout rural Ecuador and was reflected in a landslide victory for the Correa candidacy in 2006 with the mandate to hold a constitutional assembly and put an end to the political oligarchy. Additionally, previous blind acceptance of the *técnicos* and their technologies began to become questioned. For example, a farmer from San Gabriel said, "First the *ingenieros* told us to use agrochemicals. Now they are telling us not to use them. Whom are we supposed to believe?" When I arrived in Piartal during my final visit in 2006, the President of the Farmer Field School told me that the previous night they had ordered a pesticide salesman to leave town. He said the farmers had grown tired of being taken advantage of by the industry. As far as I know, that had never happened in Carchi.

Discussion

The agricultural treadmill of Carchi

Carchi produced a unique expression of Cochrane's (1958) agricultural treadmill. As we saw in the four communities, following agrarian reform and land acquisition, a large number of smallholder farmers rapidly converted to market-oriented production of a single crop: potato. As a result of this structure, they became "price takers," so getting ahead depended on stepping on a treadmill of continual technological innovation. Early on, essentially all farmers took on debt to finance access to externally based technologies, such as potato seed, mechanised tillage, and agrochemicals. At first, groups of farmers produced collectively. Nevertheless, in all four cases people quickly chose to divide up property so that individuals could own land and thereby obtain access to loans and have greater control over their production systems. This development was accompanied by the growth of an

[33] This event is further described in Chapter 7.
[34] Personal communication with Fausto Merino, Sub-secretary for the Highlands and Amazon, Ministry of Agriculture, January 2002.

agriculture support industry made up of government research and extension agents from MAG and INIAP, agrochemical vendors from private national and international companies, and lending institutions, particularly the public *Banco de Fomento*, which together became an indispensable part of *Carchense* agriculture. Within a decade of agrarian reform, a large number of smallholder farmers in Carchi adopted modern agriculture technologies and integrated with commercial markets, leading to substantial increases in production by area and worker productivity (Barsky, 1984 and Figure 4.8). By the end of the 1970s, Carchi became Ecuador's largest producer of potatoes, and farmers there began to accumulate wealth.

As found in the four communities studied in this Chapter, a decade later this prosperity began to take a turn. In contrast to Cochrane's explanation of the agricultural treadmill, however, this did not necessarily occur due to a saturation of the market and a decline in prices or because certain farmers could not keep up with the innovation of others. The combined effects of a highly variable mountain environment and climate, pest outbreaks, and lack of storability of potatoes in Carchi made supply highly unpredictable, leading to unstable prices (Figure 4.13). Additionally, environmental and ecological disturbances associated with modern agriculture led to new pest problems and soil degradation, making external inputs in the forms of pesticides and fertilizers indispensable. Meanwhile, in the 1990s, international pressure would cause the government to withdraw public support for research and extension as well as credit, leaving agricultural support in the hands of private industry.

It is possible that increases in production costs would have been offset by higher potato prices, if it were not for the porous borders with Colombia and Peru. Following economic instability during the 1990s and dollarisation in 2000, input costs rose dramatically (by about 300 percent), leading to sharp increases in the cost of production for Ecuadorian farmers (Figure 4.10). Meanwhile dollarisation created a comparative advantage for farmers in Colombia and Peru, which led to the importation of potatoes, thereby filling the void of supply in Ecuador and counteracting potential price increases for *Carchense* farmers (An, 2004).

In contrast to Cochrane's (1958) agricultural treadmill, *Carchense* agriculture did not experience scale enlargement in potato production. While farmers continued to rely on the potato-pasture system for livelihoods, the concentration of potato cultivation per farm family decreased from a high of about 7,000 families planting 15,000 ha per year (2.14 ha of potato/family) in the early 1990s to about 4,200 families planting about 6,200 ha per year (1.47 ha of potato/family) in 2000 and 2004 (MAG and INEC data). According to Herrera et al. (1999) and the most recent MAG and INEC data from 2004, the land tenure structure of potato production in Carchi had not changed significantly following land distribution. Roughly 65 percent of Carchi potato production remained in the hands of smallholders (owning less than 10 ha), 20 percent in medium size producers (10 to 20 ha), five percent in large producers (greater than 20 ha), and ten percent in landless farmers, who commonly obtained access to land through rental arrangements and sharecropping.

According to Paredes (in process), essentially all farmers from the four communities we studied who had abandoned agriculture and migrated to urban centres or other countries avoided selling their land. Instead, emigrants loaned or handed over land to family members, who converted it to pasture for dairy and cattle production or rented it to others. The modality of land rental may have contributed to some scale enlargement in terms of potato production per individual producer. Nevertheless, this growth in scale usually was not achieved through land ownership, but rather through share cropping with moneylenders who owned local businesses or who received remittances from family members living abroad.

In summary, price declines did not drive the "rat race" of the agricultural treadmill in Carchi. Instead, it was driven by price variability associated with the inherent difficulty of farming in the highland Andes, all of which was aggravated by what Röling and Jiggins (1998) describe as the "second-generation" problems associated with modern agriculture – i.e., the externalisation of human health and the environmental costs of external input, market-oriented production. As summarised in Chapter 2 and described by farmers of the four communities presented in this Chapter, modern potato production in Carchi generated serious human health problems due to pesticide exposure as well as environmental problems in the forms of chronic pest outbreaks and soil fertility decline. In addition to the externalisation of costs, the aforementioned inflation of input costs associated with dollarisation worked against *Carchense* potato producers, causing many to go into debt and, most recently, to abandon agriculture. Further, when potato production became more expensive in Ecuador, imports from Colombia and Peru filled voids in supply and tended to keep down prices. According to this analysis, over time an interactive combination of economic, social, and environmental factors made modern potato farming in Carchi unsustainable.

Rural transformation

Drawing on ecological, economic, and to a lesser extent, social perspective, "resilience" theory attempts to explain the spontaneous and unpredictable dynamic cycles of social organization and collapse apparent in interactive human-natural systems (Gunderson and Holling, 2002). Holling (2000) proposed the "lazy eight" as a stylized representation of ecosystem renewal (Figure 4.15). The cycle is based on two central elements of spontaneous adaptation: (1) the *potential* that is inherent in the accumulated "capital" of natural resources or social organisation (Y-axis), and 2) the degree of "connectedness" between variables (X-axis). Low connectedness is associated with loosely connected, diffuse elements and high outward relations and influence by outside variability. High connectedness is associated with tightly aggregated elements and inward relations and limited outside influence and externally driven variability. The interactions of the X- and Y-axes produce four phases:

1. Conservation (K) – slow change; resources structurally "locked up"
2. Release (Ω) – rapid change; previously locked up resources released
3. Reorganization and renewal (α) – system boundaries tenuous; restructuring around emergent opportunities
4. Growth and exploitation (r) – resources made available

The exit from the cycle at the left of the figure describes how certain potentials may escape the system to catalyze new adaptive cycles.

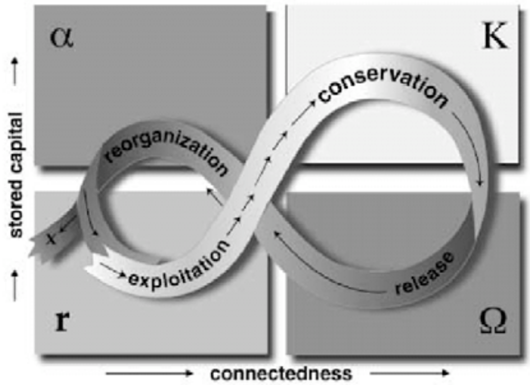

Figure 4.15 The "lazy eight" adaptive cycle (Holling, 2000)

Holing (2000) utilises this model to describe the alternating fluctuations between longer periods of aggregation and transformation of resources and shorter periods of "opportunities" for exploitation and reorganisation as fundamental dimensions of complex systems – from cells to ecosystems to societies. Other authors have applied this cycle to describe diverse phenomenon, including organisational development (Hurst, 1995), Integrated Pest Management (Röling, 2005), natural resource management (Maarleveld and Dangbégnon, 2002), and water management (Jiggins et al., 2007).

Holling (2000) describes transformation in socio-biological systems as the release of accumulated tendencies. Change is dependent on three interacting processes: myopia, pathology, and reflex. Myopia involves, for example, a conceptual limit of institutions that may lead to a fragmentation or structural distancing with a locality. In Carchi, for example, modern institutions of agriculture came to preoccupy themselves with the forces of distant markets, which eventually drove farmers to substantially change crops and varieties, planting schemes and rotations that survived in the *wasipungos*. This represented a structural break with long-established forms of organization, which could be described as a "loosening" of the coupling between local culture and the environment. As observed in this chapter, the products of this uncoupling included diverse forms of environmental pathologies expressed in the fields of farmers. As they organised around private interests, the activity of institutions, such as the hacienda and later the scientific and agrochemical industries, deepened tendencies. This chapter shows how a certain "entrenchment" around modes of technology such as mechanised tillage and agrochemicals has led to dysfunctional environmental interactions. Associated pathologies produced socio-biological feedback. Emergent reflexes contained elements of past legacies, such as an existing social hierarchy, as well as innovations, such as land redistribution and the introduction of new market arrangements and technologies. Reflexes led to reordering of social forms and interactions with the environment, such as those associated with the transition of the hacienda system to post agrarian reform society.

Drawing on the historical information presented in Chapter 3 and the socio-biological developments around modern agriculture presented in this chapter, Table 4.6 is an attempt to summarise the global processes of rural transformation in Carchi. The central qualities of socio-biological change during the Cuasmal period appeared to be characterised by episodic change, meaning periods of slow accumulation of natural or social energies punctuated by sudden releases and reorganizations of earlier legacies. Beginning with the Incan and Spanish arrivals, periods in Carchi were marked by historical contingencies with relatively slow aggregating socio-biological variables and faster disaggregating tendencies. Periods of consolidation and the emergence of new organization and stability followed. In modern time, the pathology of ecosystem decline has reached epidemic proportions. Similar to Giddens' (1990) explanations of "reflexive modernisation," drivers of transition led to transformations of epoch, marked by seemingly isolated and interactive socio-biological reorganizations.

Table 4.6 Global processes of rural transformation in Carchi

Period	Socio-cultural novelties	Biophysical novelties	Slow, aggregating variables	Fast, dis-aggregating variables	Drivers of transition
Cuasmal	• Closed socio-technical systems • Vertical organization of agriculture	• Stable ecologies • Highly moist to wet conditions • Inhospitable environment	• Internal cultural dynamics • Caste system	• Climate • Opening of economies	• Incan arrival • Spanish arrival • Social upheaval and war
Hacienda	• Exposure of economies • Horizontal organization of agriculture • *Encomienda* (indentured servitude)	• Deforestation • Introduction of species • Extensive agriculture	• Heightening social domination and control • Ecological limits	• Climate • Expanding external markets • Introduction of species • Urban growth • Social disparities and conflict	• Urbanization • Market growth • Technology developments • Population growth
Land reform and technification	• Open economies • Resource re-distribution • Land privatisation • Market integration	• Potato-pasture monoculture • Continuous cropping	• Social re-distributions • Rise of external inputs and technologies • Financial dependencies	• Unequal financial rewards • Initial crop failures • Price variability	• Industrial development • Market growth • Globalised markets
Dollarisation and trade liberalization	• Highly open economies systems • Deepening of market integration • Political instability	• Declining potato cultivation • Increasing pasture • Testing alternative crops (broccoli, flowers)	• Technology dependencies • Financial dependencies • Market domination	• Pest and disease outbreaks • Declining soil fertility • Price variability • Emigration • Conflict	• External-oriented markets • Ecosystem collapse

A global tendency of modernity in Carchi, beginning with the Incan and Spanish arrivals and deepening since, has been both a simultaneous and interactive ecological and social disconnection, what I refer to as a systematic "disembedding" from localities. The research presented in this thesis suggests that through the undermining the fundamental mechanisms of ecosystems and social relations, it may represent a systematic breakdown of the earlier described adaptive mechanisms. The result is not just a reflex in a cycle, but a destruction of the cycle's integrity. The novelty is that this event is the result of human-dependent activity. If this were true, the expected product would not be resurgence, as described by Holling, but rather an endless rise of uncertainty.

Historically, after two or three cropping seasons, land became biologically and chemically fatigued, which led farmers to leave fields to fallow for "rest" or recuperation. Nevertheless, in the 1990s farmers began to find that fields did not recover as previously. They generally began to experience falls in productive capacity of land and insect pest and disease epidemics became increasingly common. The land had lost its recuperative capacity despite continual and usually increasing use of agrochemicals. As a farmer from San Pedro explained, "In my father's time, they produced 30 or 40 [potatoes harvested] to one [potato planted]. And they did not use chemicals. Now, we cannot even expect ten to one."

During each episode in Carchi, stability led to accumulated potential and resources and environmental capital. Simultaneously, this signified accumulated vulnerabilities. Over time, social systems became less resilient and more sensitive to some internal or external catalytic event. For the Andean weevil, it was monoculture and the accumulation of potato leaves as an energy source that fuelled proliferation. Foci of late blight epidemics on potato led to spore showers over entire regions and increased prevalence of the pathogen. The shift towards continual cropping led to strategic depletion of soil nutrients associated with the continual growth of a single crop and variety, which in turn led to "weaker" plants, increasingly vulnerable to insect pests and diseases.[35] After reaching a maximum potential in the early 1980s, the system of monoculture increasingly appeared to become a manifestation of what Beck (2001: 269) called, "… an accident waiting to happen."

Holling (1973) explains that historically, human-nature interactions appeared to be "tightly wrapped". In the Andes, endless novelties were tied in with this robustness, such as diverse soil biota capable of regulating unstable conditions. For example, entomopathogens that evolved on the Andean weevil increased in populations with the pest until they too fell vulnerable to change. Further mycorrhizae could enable plants to compensate for nutrient imbalances until other soil distortions became so severe that they too fell off, demanding increased fertilizer applications to sustain crop yields. Additionally, potato varieties included chemical or morphological means to warding off *P. infestans* until the pathogen mutated and overcame them, demanding a change of variety or more commonly increased fungicide use. In the end, a perceived acceleration of change coupled with practices, such as pesticides and mechanised tillage, that indirectly killed off recuperative biological mechanisms appeared to have outpaced environmental means of adjustment. From a human perspective, this brought about system failure and collapse. In reference to

[35] Chauboussou (2004) explains the biochemistry involved plant health decline as a result of modern agriculture.

academia's preoccupation with market-oriented, external input agriculture, Röling (2006) summarised this phenomenon as the product of the "death sciences" – i.e., an emphasis on the abiotic factors of production (e.g., nutrients), rather than the biological conditions that sustain life and ecological processes in agriculture.

Thinking about multinational corporations and industry, the economist Schumpeter (1987) described the phenomenon of "creative destruction" – destruction in the sense that it triggered system collapse, but also creative in the sense that it released energy that fuelled new organization and social forms. From a human ecology point of view, the Cuasmal civilization fell victim to the arrival of the Incan Empire, which in turn, fell victim to the Spanish Conquest. Each time, societies settled into new structures that, over time, were marked by accumulation of potentials and vulnerabilities. Internal or external forces led to collapse and change. In modern time, the novelty was a perception of accelerated rate of change, technologies of "death," and effects at new scales.

As presented in Chapter 3, traditional agriculture distributed risks across vertical ecologies. The hacienda system reorganized this arrangement during the 18th and 19th centuries around markets in distant cities or Europe. The horizontal redistribution of farming in the highland Andes eventually lead to the accumulation of cropping vulnerabilities to climate, pests and disease that, from a biological systems perspective, would demand new compensating mechanisms. This created the conditions for the introduction of agricultural technologies and the growth of a new industry in Carchi and elsewhere in Ecuador that decades later would become a powerful social force capable of shaping science and education policies as well as entire ministries, congresses, and administrations – i.e., government. I will further explore this occurrence in Chapter 7.

The growth of urban-based populations in the 1950s and 1960s increased the demand for food production, which led to the need for increased agricultural productivity. The low productivity of extensive agriculture combined with the exploitative labour conditions of the haciendas led to an accumulation of potential and vulnerabilities and release as agrarian reform. An emerging industrial agri-technology power matrix quickly repackaged agrarian reform policies as "intensification" through credit and green revolution technologies, which in turn led to a commoditization of rural life and a tying of smallholder farmers to relatively external and distantly referenced markets.

The growth of the agrochemical industry and its increasing influence in government during the 1970s and 1980s led to an end of the land distribution component of agrarian reform before the policy was fully meted. In its stead, the industry re-emphasized agriculture intensification through further "technology adoption" and "market integration" leading to the *Ley de Fomento Agrícola* in 1979. The subsequent Law of Modernisation of the Agrarian Sector in 1989 further entrenched these tendencies around notions of enabling smallholder producers to "compete in the global marketplace."

At the end of the 1990s, the collapse of Ecuador's banking system led to the "dollarisation" monetary policy that generated triple digit inflation and sharp increases in the country's poverty rates. In Carchi, agrochemicals prices and labour costs increased dramatically without an increase in potato prices. These tendencies coupled with outbreaks of the Guatemalan tuber moth caused the area of potato production to drop from about 15,000 to 8,000 hectares in 2004, with most farmers leaving systems in pasture fallow and living off of milk production. When we visited in 2005, the deepening financial crisis was causing farmers to slaughter cows to pay off debts, and several had abandoned farming and were working as labourers in remaining haciendas or the flower industry.

In the early part of the twenty-first century, farmers began to describe the natural environment as “exhausted" and "inhospitable” for farming and the social environment as increasingly "fragmented" and "anti-social,” even "hostile.” Some felt that they were better off under the hacienda system, when at least someone, the *patrón*, cared about them. Many farmers did not want their children to continue in their footsteps. Previously, some had wanted their sons to become *ingenieros*, but due to a growing distrust in *técnicos* or experts, they had changed their minds, deciding it would be best for their children to become computer or information technicians or not to study at all and to go into business in the cities. Youth were migrating to the cities to study or in search of work. In other cases, youth had “disappeared,” which commonly meant that they had joined one of the revolutionary groups in Colombia.

Farmers spoke in richly diverse ways of mistrust in earlier authority figures such as the *técnicos* and officials from the municipality. One night during a workshop a farmer got up to tell a joke: “How does an *ingeniero* change a light bulb? First he checks his books. When he does not find an answer, he calls a meeting in his office, where he asks a farmer to do it, that is, after charging him for the light bulb.” The *ingenieros* and politicians became the target of jokes. Two of the four villages in our study had chased away agrochemical salespeople. It was common for rural people to label public authority and government as "corrupt" and increasingly "out-of-touch with reality.”

Perhaps more important than the farmers who were forced to abandon agriculture in recent time were the farmers who managed to carry on. In 2004, Paredes and I found that farmers from communities with relatively ample soil and water resources, such as Mariscal Sucre and Libertad, still managed to survive the *Carchense* agricultural treadmill in comparison with their counterparts from lesser endowed Piartal and Cuba (Table 4.5). Additionally, Paredes (in process) found significant differences across the farming styles of individual households. Farmers who relied heavily on external inputs (locally known as *arriesgados* or high-risk takers) failed disproportionately. In contrast, those who favoured local knowledge and technology, employed family labour, and nurtured broad social networks (the *curiosos* or inquisitive and pragmatic farmers) were more effective at avoiding the risks associated with modern potato.

According to the resilience literature that is summarized in Gunderson et al. (1995) and Gunderson and Holling (2002), it is inevitable that the limits of a compensating mechanism will be reached. Nevertheless, modern co-developments have permitted the perpetuation of what scientists, farmers, government officials and industry representatives increasingly understand as forms of self-destructive behaviour. In ecological terms, the compensating mechanisms – i.e., agrochemicals – enabled increased potential to the point where one could expect an increasingly violent release – in environmental terms, social ones, and perhaps both.

Conclusions

In reference to agricultural intensification as "the misguided utilisation of chemical pesticides and fertilisers," the French plant physiologist, Francis Chaboussou, concluded that healthy plants resisted pests and disease and agrochemicals actually weakened crops by interfering with the chemical and ecological processes of resistance. He argued (2004: 209), "…we need to overcome the idea of 'the battle': that is, we must try to annihilate the parasite with toxins that have been shown to have harmful effects on the plant, yielding the opposite effect to that desired." Instead, Chaboussou called for a "revolution in attitude," followed by a complete change in the direction of research towards crop health. In other words, agriculture needed to learn to work with, rather than against, biology and ecological systems. Carchi is a case in point.

Following agrarian reform, smallholder potato production based on mono-cropping and externally sourced technologies, especially mechanized tillage, synthetic fertilizers and pesticides, quickly transformed the *Carchense* landscape. As a result, short-term production, both by area and labour input, intensified dramatically. Production increased to three times the national average, and productivity in terms of return on investment and labour heightened. Nevertheless, this progress did not occur without cost.

Market integration and technification were accompanied by potato monoculture, a decrease in planting distances, the introduction and increased use of agrichemicals, and a shortening of fallow periods. Over time, market forces led farmers to greatly reduce the potato biodiversity of their fields. A very fragile, chemically intensive monoculture of a single dominant variety, Superchola, came to predominate the landscape. Such changes had severe consequences on the ecology and, due to chronic exposure to the compensating intervention of agrochemicals, human health. Further, economies became affected.

By the mid-1990s production by area and productivity levelled off and declined. Concurrently, real prices for inputs grew – chiefly as a result of dollarisation of the economy – and market prices for potato showed increasing rates of variability, with an overall tendency towards decline. Studies beginning in the early 1990s showed that farmers lost money on a majority of their plantings – from about 43 percent in 1991-1992 (Crissman et al., 1998) to over 60 percent in 2004 (Paredes and Sherwood database, 2004). At the same time, farmers and their families suffered adverse health effects as a result of their continual exposure to chemicals (Cole et al., 1997a and b; Cole et al. 2002), which negatively influenced the economy of farm management (Antle et al., 1994; Antle et al., 2003). While agricultural modernisation brought increased production and wealth in the short-term, ultimately it undermined the stability of agro-ecosystems and worked against the economic interests of rural families, leading to collapse.

The longer-term social effects of modern agriculture were equally dramatic. Processes of transformation from the hacienda signified a break with the cruel exploitation of the hacienda system, but they also led to new mechanisms of control. Over time, the independent *Pasto* indigenous groups of Carchi became the *wasipungos* who, in turn, became today's rural poor, highly vulnerable to the environment and the market and in need of external assistance in the forms of technologies and technical assistance. Thirty-five years after market integration and technification, an increasing number of rural families found themselves in a crisis they called "dollarisation." The fragile natural resource base and volatile compensation for commodities endangered earlier bimodal systems of production. This period was marked by growth of two sectors: the landless labourer and the urban migrant. A product of agriculture modernisation was a simultaneous and interactive ecological and social disembedding that, over the long term, ran in counter to the well-being of farmers and their communities. Increasing rates of abandonment of agriculture and emigration suggested that modernisation placed into question the viability of rural life.

Chapter 5

Cultural Encounters: Learning from Cross-disciplinary Science and Development Practice

Stephen Sherwood, Donald Cole, and Charles Crissman[1]

Summary

Overcoming ecosystem health challenges calls for breaking down disciplinary and professional barriers. Based on reflection of the Eco*Salud* project that used both research and development action to address pesticide-related concerns in Carchi, this chapter presents the conflicts and the accommodations made between the two dimensions with respect to such issues as staff recruitment, baseline assessments, community education, and advocacy. In so doing, it exposes underlying problems of paradigm and process inherent in bringing researchers and development practitioners together and the problematic role of advocacy associated with joint agriculture and health, research and development initiatives.

Introduction

Throughout Latin America, as in other parts of the world, human activity is increasing the pressure on ecosystems, which in turn feed back onto livelihoods and well-being. As Ulrich Beck (1992) makes clear, the complex biological and social consequences of ecosystem decline spin off effects that cut across geographic, disciplinary and professional boundaries, rendering earlier designs of ecosystem analysis and management obsolete. Researchers and development practitioners are under pressure to answer this challenge with new ways of conceptualizing concerns and mobilizing effective change.

In recent times, scientists, development agents, and the public increasingly have become aware of the multi-dimensional nature of ecosystem decline,[2] and hence the need to co-operate across scientific disciplines and professional and practitioner cultures. Research methods are expanding to simultaneously accommodate not only biophysical aspects of agriculture and health, but also the ecological and cultural systems from which practice emerges and operates, leading to an erosion of the boundaries between scientific disciplines as well as between science and rural development. Emergent approaches are steering rural development practice towards interactive designs that emphasize social "brokerage" among actors (for a comprehensive explanation, see Leeuwis, 2004). While it

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[1] A version of this chapter was originally published as: S. Sherwood, D. Cole, and C. Crissman. 2007. Cultural encounters: learning from cross-disciplinary science and development practice over ecosystem health. *Development in Practice*, 17(2): 179-195.

[2] See for example, van Haaften et al. (1998), which shows that psychological factors such as stress and alienation proved to be highly correlated with land degradation in African villages of the Sahel.

is commonly assumed that such brokerage needs be applied to mediate the differences between external projects and communities, we found the challenges of cross-disciplinary practice to be substantial. Differences clearly exist among academic disciplines – from health professionals, to agronomists, economists, and sociologists. Contrasts underlay the assumptions, perspectives, values, and practices of quantitative researchers and grassroots development practitioners.

In this chapter, the authors – a rural development specialist, occupational/environmental health specialist, and agricultural economist – share their experience with a joint knowledge generation and development intervention for greater ecosystem health in Northern Ecuador. For each, established approaches to conducting work became uprooted, at times leading to questioning the usefulness of the collaboration. Eventually, common ground was found, or rather built, however imperfect. This paper examines the challenges encountered and the compromises made, as it highlights remaining issues for the design and practice of interactive cross-disciplinary research and development.

Setting the scene: Eco*Salud*

Pesticide dependency is one unexpected and undesired outcome of science and development policy, with health consequences globally (for examples, see: Dasgupta et al., 2002; Eddleston et al., 2002). Since the early 1990s, a number of national and international organizations have been working with communities in Carchi, Ecuador's northernmost province, to assess the role and effects of pesticide use in potato production and to reduce its adverse impacts.[3] Carchi is nationally famous for potato production, growing 40 percent of the country's potatoes on only 25 percent of the land dedicated to the crop. Although potato has been a staple crop in the Andes for millennia, industrial technologies, such as tractors and agrochemicals, and market integration have driven unprecedented agricultural intensification. Fertilizers and pesticides have enabled increased potato production, but at great costs to ecosystem health and exposing farmers to toxic substances.

Researchers provided quantitative assessments of community-wide pesticide use and its adverse effects during a first phase of research in Carchi. A full summary of the research is beyond the scope of this paper but has been reported in detail elsewhere.[4] Most alarmingly, rates of pesticide poisoning among the rural population were among the highest reported in the world. Medical and psychometric testing revealed that two-thirds

[3] Principal collaborators included: INIAP (National Institute of Agricultural Research from Ecuador), CIP, Montana State University (USA), McMaster University and University of Toronto (Canada), Wageningen University (the Netherlands), and the FAO's Global IPM Facility.

[4] The research in Carchi has been widely published (see Appendix A) and is summarized in two compendia: Crissman, Antle, and Capalbo (1998) and Yanggen, Crissman, and Espinosa (2003). The initial economic research on the productivity impacts of pesticides was first published in Antle (1994). The pesticide poisoning research appeared in Cole, Carpio, and Leon (2000). The results of two in-depth sociological studies on the effects of pesticides on women and farming styles can be found in Mera-Orcés (2001) and Paredes (2001). A description of the development approach and lessons learned can be found in Sherwood, Crissman, and Cole (2004). Summaries and a link to a two-part BBC World Service Program on pesticide use in Carchi can be found at: www.bbc.co.uk/worldservice/specials/1646_dying/index.shtml.

of the rural population suffered neurotoxic effects from pesticide exposure. Among farmers, these effects were associated with measurable decreases in farm productivity. Through system modelling, we demonstrated the potential of different strategies to lessen pesticide dependency and thereby improve ecosystem health.

Canada's International Development Research Centre (IDRC) established the Ecosystem Approaches to Human Health Program on the belief that ecosystem management affects human health in multiple ways and that holistic, gender-sensitive, interactive approaches to identification and remediation of the problem was the most effective manner to achieve improvements (Forget and Lebel, 2001; www.idrc.ca/ecohealth). The research into health improvement proposed under the ecosystem approach to human health considers two principal aspects: exploration of determinants of health (be they environmental, social, cultural, or economic) and attention to associated socio-environmental interactions. In development terms, this line of research is intended both to critically assess how interventions may mediate change consistent with ecosystem health goals. The program demands extensive community involvement in research as a means of assuring project accountability to local interests (Figure 5.1).

Figure 5.1 IDRC's iterative strategy for improving ecosystem health (Forget and Lebel, 2001)

The model mandates a mix of research and intervention while incorporating attention to social diversity and more deliberate interaction among scientists, community stakeholders, and policy makers in the construction of alternatives. While fine in theory, such design embodies inherent contradictions associated with current research and development practice. This chapter shares reflections on the experience from one IDRC Ecosystem Health funded project – Eco*Salud*. We implemented our project in three stages:

Stage I: Start-up and engagement

This stage involved community selection, recruitment of families from those communities willing to participate in both the research and intervention activities, the commencement of data collection and the initial participatory encounters with individuals, families and the community. Once we selected the three community locations, it included baseline surveys, followed by preliminary data analysis to guide the overall project plan. After meetings with communities where past research and initial findings were discussed, individuals and families were encouraged to enlist in learning activities, especially Farmer Field Schools (FFS). Originally scheduled for six months, stage I lasted nine months due to delays in staff training, development and testing of research tools, and information collection and preliminary analysis.

Stage II: Expansion of community activities

This stage involved completion of the neurobehavioral measurements and on-going research on specialized themes, such as identification and documentation of pesticide exposure pathways and measurement of individual nutritional status, a potential confounding factor in neurobehavioral impacts. It also involved implementation of FFS in each community, educational campaigns, and other intervention activities. We planned to complete this stage in one year, but it lasted nearly two years, with certain activities continuing through to the end of the project.

Stage III: Reassessment, sustainability and policy efforts

The stage included the completion of ex-post neurobehavioral assessments and visits to each participating farm household to assess changes in pesticide practices. It included efforts to inform the public on preliminary research outcomes and advocate policy, both in Carchi and at the national level. The project ended before we fully achieved our policy objectives, but fortunately new partner initiatives took up some of what Eco*Salud* left behind.

Throughout these stages, implementation of the varied research and development tasks in Eco*Salud* involved continual negotiations among team members. Table 5.1 summarises points of difference that emerged during the project and associated outcomes and consequences. We go on to highlight four decisive moments: staff recruitment, quantitative design and data collection, development intervention design, as well as advocacy and policy intervention.

Moments of divergence

<u>Staffing</u>

Divergent ways of seeing, valuing and doing first surfaced during staff recruitment. A CIP Senior Scientist, an agricultural economist, was the Eco*Salud* Project Leader. He recruited two Ecuadorian agricultural researchers who had participated in the first phase of research in Carchi: a farming systems specialist from the national agricultural research institute (INIAP) and an agricultural economist on CIP staff who would lead the research component and take responsibility for quantitative objectives associated with before-and-after measurements. A medical doctor and occupational/environmental health specialist based in Canada, who also had participated in the earlier research, continued to support the health research components of the project as well as providing input to health-related training activities. In addition, a rural development and Integrated Pest Management (IPM) specialist was hired to lead the training and development component.

Table 5.1 Outcomes and consequences of clashes between the Eco*Salud* research and development teams

Moment of divergence	Research perspective	Development perspective	Outcomes and consequences
Staff recruitment	Technical expertise	Cultural background and facilitation skills	• Technical skills with investments in participatory training
Preoccupation	Rigor; high quality information and analysis	Relevance to community's interests; high quality process	• Rigor over relevance
Project planning	Based on objectives; pre-established plan	Based on learning; interactive and iterative process	• Pre-established plans with milestones generally not met by staff
Baseline	Objective, reliant on high quality information prior to project intervention	Subjective; should be based on methodologies such as a participatory rural appraisal	• Lengthy structured surveys; communities unmotivated by intrusive questions • Corruption of baseline
Project sample selection	Should be random and representative of the population	Self-selection based on interest	• Self-selection bias of Farmer Field Schools (FFS) • Difficulties with quantitative design and statistical analysis
Sample maintenance	Minimize sample loss to protect investments in data collection and maintain observations for statistical analysis	Greater tolerance for participant drop out from pesticide education interventions	• Selected interventions designed to cover all participants without option of self-selection
Understanding of change	Better information; effective technologies	High quality dialogue and social learning	• Technologies over process
Intervention design	Based on outcomes of research and technology transfer	Based on community priorities and capacity building	• Focus on project priority: pesticides • Difficulty with community participation, especially during financial crisis
Participatory approaches to training	Effective but slow and expensive	Necessary investment for lasting change	• FFS became the lead methodology
Community incentives	Financial incentives acceptable for inspiring change in practice	Financial incentives inappropriate and interfere with local initiative	• Use of interest-free loans for personal protective equipment
Political intervention	Conflict with researcher mandate of neutrality	Appropriate and necessary for change	• At first limited to information, but later, as the industry became involved, pro-active advocacy

The Eco*Salud* leaders employed a field level staff made up of both research assistants and community facilitators based at the INIAP provincial office in Carchi. They would be in charge of data collection, community organization, and training. The first differences among the project leaders arose over women's representation in the staff. Some leaders were more committed to hiring women, while others were more concerned with hiring people who they could count on to complete tasks and act as confidants. Based on the all male presence in the INIAP field office and the Eco*Salud* leadership, bolstered by IDRC's demands for gender balance, we agreed to give preference to woman applicants. On the thematic side, the researchers expressed preoccupation over the formal technical qualifications of staff. The national staff emphasized a notion of professionalism that was based on formal degrees and the capacity to present oneself with authority. Meanwhile, the lone development expert emphasized field-oriented people with strong communication and process management skills.

A limited pool of professionals responded to our announcements in provincial newspapers. We found that individuals with the technical training and expertise for which we were searching were not generally available in Carchi. We hired a man from the centre of the country who had been a former student of one of the researchers and was his trusted confidant. The development leader was at least satisfied that this person came from a rural village and had practical farming knowledge. The candidate also had conducted his BSc level research in Carchi and was at least familiar with its rural history and social dynamics. The remaining two hires were women, only one of whom lived in Carchi: the nurse. The other woman was a gender specialist who had worked with domestic violence in a nearby city. We found it difficult to find a female gender specialist who was willing to subject herself to the difficulties of rural living in Carchi. She would have to relocate, bringing with her a husband, who was unlikely to find a job, and her child, who would need to leave behind the higher quality schools of the city. Fortunately, her parents had originally come from Carchi, so she was open to the opportunity of living and working there. Like others, certainly the scarce opportunity for employment must have been a motivating factor. Box 5.1 provides a summary description of the staff.

Eco*Salud* was staffed with people from distinct research and development cultures, generations, academic backgrounds and professional orientations who contributed diverse perspectives to the project dialogue. We found that differences in gender, nationalities, and organizational cultures, combined with conflicting perspectives over roles and priorities all contributed to tensions during different moments of the project. Though the project was administratively a single unit, functionally it divided into two research and development teams. Conflicts between the teams emerged during initial baseline work and ensuing project planning.

Quantitative design

Eco*Salud* sought to combine rigorous quantitative research while simultaneously stimulating behavioural change through farmer- and community-led interventions, which we generally referred to as "participatory development." The final design, the result of negotiations among the staff, included elements of linear, mechanistic logic needed to accommodate the demands of quantitative research as well as more open-ended and consultative learning process that sought community involvement in on-going information processing and the construction of responses.

The principal research hypothesis was that participatory training would result in reduced use of neurotoxin pesticides, which in turn would bring about improvements in participants' neurobehavioral function. The participatory training and other community activities were to evoke individuals and communities to make more informed decisions about pesticides that would lead to a reduction in their exposure. The research hypothesis required quantitative data collection on knowledge, attitudes and practice about pesticide use, identification of direct and indirect pesticide exposure pathways and measurement of the neurobehavioral status of individuals (Cole et al., 1997a) before and after the training and presumed changes. The research team needed measurements of a representative sample of individuals before and after the interventions. The validity of the inferences that could be drawn from the measurements rested on respecting established statistical procedures for sample selection as well as community consultations.

Box 5.1 Eco*Salud* team members

Researchers

- Project leader – US-trained PhD level economist. Experience in S.E. Asia and the Andes. Knowledgeable with production and productivity concerns of rice and potato systems. A talented communicator and well-liked leader, a convener and conflict manager.
- Research component coordinator – Ecuadorian- and US-trained MSc level economist, with expertise in potato and production economics. Traditional and pragmatic; good manager of activities, preoccupied with quantitative rigor.
- Development component coordinator – US-trained MSc level pest management and adult education specialist, with 12 years of experience in discovery-based approaches to integrated pest management in Central America. A knowledgeable generalist; strong connection with rural poor and social change interests.
- National economist – INIAP staff assigned to the project; Ecuadorian- and Chilean-educated MSc level economist, experienced in farming system economics and linear program; preoccupied with rigor and technology transfer.
- Human health specialist – Canadian-trained and based M.D. and MSc epidemiologist with occupational/environmental health expertise; experience in community health programs in Central and South America. Multi-faceted, familiarity with quantitative and qualitative approaches.

Field staff

- Gender specialist – Ecuadorian BSc level educator with expertise in women's development concerns. Talented facilitator, sensitive to gender issues, especially domination of women.
- Nurse – Ecuadorian BSc level nurse, with medical centre and farm management experience. Lone Carchense of the group, pragmatic and with no previous community development or project implementation experience.
- Agricultural extension agent – Ecuadorian BSc level agronomist with soil conservation expertise. Rural background, pragmatic and hard-worker; preoccupied with farmer relevance.
- Temporary enumerators and researchers – Numerous BSc and MSc level students who implemented project surveys and conducted extractive research on specialized topics, such as nutrition, farm economics, pesticide soil and water contamination, farming styles, etc.

Meanwhile, the development team sought to implement change through participatory approaches that rested on individuals expressing willingness to work with us on interventions. It proposed methods that were incremental and resulted in piecemeal recruitment of participants. For the researchers, sample selection and sample maintenance became one of the fundamental sources of tension. The development team continually struggled to limit extractive activities and orient project resources to community interests.

In response to its design demands, the research team needed individuals as part of a representative sample of communities. The development team needed individuals as local catalysts of change. Thus selection criteria sought communities that were both representative of the potato production system and the diverse social dynamics in it. As part of its community entry strategy, the development team held open information sessions on the previous pesticide exposure and health impacts research. This caused problems for the researchers who first needed to establish a baseline study on knowledge, attitudes and practice with regards to pest management and pesticides. Participatory development demanded an open-ended process, where communities could learn about opportunities and voluntarily enlist in activities. The development team foresaw starting with a small group of families that would grow and, over time, play an increasing role in project design and implementation. From this perspective, beginning with structured surveys would interfere with that process. On the other hand, informing communities of past research findings could bias the baseline study. Knowledge, attitudes and practice surveys are especially susceptible to respondents who adjust their answers to what they think interviewers want to hear.

Agreeing on a sample was problematic. Lacking the freedom to construct a sampling frame and select from it, the researchers decided to over-sample. For the baseline survey, the economic researchers sought to include every household in each of the three communities, representing at least 100 families per community. This strategy would guarantee inclusion of anyone who decided to participate in the Farmer Field Schools. Meanwhile the health research team needed families willing to submit themselves to an adapted World Health Organization battery of neurobehavioral tests, both before and after project interventions. The health assessments and associated tests took about half a day per individual, so it was only realistic to conduct such studies with about 20 families per community. This number matched more closely with the priorities of the development team. The development team operated under the social concept of *critical mass* and was most interested in recruiting a much smaller population of 15 to 25 percent – the most progressive families – as a means of constructing alternatives and eventually catalyzing spontaneous change in pesticide use in the broader community.[5] As a result, the development team only needed to enlist 20 to 30 families in each community.

Concurrently with the research baseline surveys and assessments, the development team began to hold sessions with communities as a means of informing them of the project and enlisting participants. Although the development team tried to limit information on

[5] In the 1960s, Rogers (1983) statistically tested the concept of critical mass to describe the dynamics of technology diffusion in rural communities. Bunch (1982) applied critical mass as a strategy for enabling people-centred agricultural development.

pesticides during initial activities to not bias the baseline, it inevitably did. Furthermore, the health professionals grew frustrated that it took so long to identify the population of innovators in each community, hence decreasing time between the before and after neurobehavioral tests. The development team felt that families first needed to learn about training activities and pass through a filter of self-selection based on their interest. Researchers feared that this approach would produce a non-representative sample that would invalidate their studies. In summary, early on the researchers felt that the development team's demands both slowed down the project and placed into danger the quality of its information. Meanwhile, the development workers found problems with the social effects of extractive research.

During the process of engaging communities some farmers were quick to pick up on Eco*Salud*'s priorities and to lobby their own interests. Some sought access to cheap credit, seed, and agrochemicals. As a farmer from Santa Martha de Cuba cleverly asked:

> *Ingeniero*, I would like to ask you if it is possible to get some sacks of fertilizer as a gift form the institution [INIAP] for a new plot. I know you want to have a lot of FFS [Farmer Field Schools] everywhere, and we are the ones who will represent the results, and will tell the others that we have had a good experience. I think we can also say that the institution gave us good support. That is why we are asking for some help.

The development team expressed concern over false expectations that a community-level baseline might raise as well as over the drawn out process of health assessments that would enervate motivations and discourage families from getting involved in other activities. Indeed, the research team's lengthy interviews on production, socio-economic assessments, and medical tests taxed peoples' time and motivation. As a woman from the community San Francisco de Libertad confided:

> The *licenciadas* [interviewers] came and asked many questions. We were getting tired, but we did not tell them because they were nice people. We even became good friends with one of them, but a lot of people tried to hide from them each time they came [to conduct interviews]. People were scared of so many questions. They even asked us what we ate and the price of our electric appliances.

The reliance of participatory methods on participants' continued interest and attendance created problems for the research team. Some FFS participants dropped out. The research team had spent considerable time and funds measuring the baseline neurobehavioral status of FFS families and viewed this with concern. Due to the open-ended nature of FFS, they feared that too many of the original sample would not change its behaviour sufficiently to reduce pesticide exposure and thus measurably improve neurobehavioral scores within the project timeframe. The research team sought to guarantee a minimum up-take of technology and change in practice among the sample population to assure pesticide exposure reduction.

Intervention design

The bulk of stage II – expansion of community activities – was supposed to shift from quantitative research towards enabling farmers and their families to affect change (Cole et al., 2002; Sherwood et al., 2003). At the end of the first year, the teams came together to redesign the intervention strategies as per initial project experience. During planning workshops, it became clear that the economic researchers favoured more technology transfer approaches, while the development practitioners favoured knowledge-based approaches. Differences were not always reconcilable. For example, some researchers felt that the best way to deal with pesticide exposure was to promote Personal Protective Equipment (PPE). The development team pointed out that PPE was the central strategy of Safe Use of Pesticides (SUP) that had been promoted by the Ministry of Agriculture and the pesticide industry for decades and led to questionable results in Carchi as elsewhere (Murray and Taylor, 2000; Atkin and Leisinger, 2000). They argued that the problem was not a lack of information or technology, but rather an *internalisation* of the problem by means of awareness and knowledge raising strategies. This concurred with the occupational health literature, so with the support of the health expert, the development perspective won out. It was agreed that the second year of the project would centre on a series of in-depth, community-led activities and that PPE would come in at the end.

The standard view of IPM centres on pesticide applications based on economical thresholds and transfer of single element technologies within a framework of continuing pesticide use. In contrast, Farmer Field Schools in IPM, a methodology developed by the FAO in Southeast Asia, propose group environmental learning on the principles of crop health and ecosystem management as an alternative to reliance on curative measures to control pests (Pontius et al., 2002). Since the standard approach to IPM had not delivered results in Carchi and the project aimed to test more farmer participatory methodologies, we decided to go with the Farmer Field Schools.

During FFS sessions, the farmers, not the trainers, provide the technical expertise. What is most important for trainers is a base knowledge of pest biology and ecology and strong facilitation skills. To introduce FFS in Carchi, we decided to send staff to an intensive three-month training of trainers (ToT) in FFS methodology that was led by the FAO's Global IPM Facility. Selecting staff to participate in the ToT exemplified the multiple and complex biases faced on grounds of gender, professionalism, and project-based employment. The development expert had hoped to send both a male agronomist and a female sociologist to the ToT. Nevertheless, research team members failed to see the relevance of sending a non-agronomist. Furthermore, one leader only wanted to send permanent staff, in part because "soft" project money financed temporary staff, and it would be difficult to cover responsibilities for three months. As a result, only one trainee was sent: the permanent hire male INIAP agronomist.

INIAP's staff had great difficulty appreciating the differences between vertical extension delivery and enabling farmers to find their own solutions to problems. The concern had deep cultural, institutional and philosophical roots that were not easily pruned. Rather than facilitate experiential learning in the field, for example, extension agents were inclined to give presentations in classrooms. Rather than use questions to elicit group introspection over concerns, extension agents gave answers. Nevertheless, with extensive training, supervision and follow-up, a number of INIAP agronomists became high quality FFS facilitators and have gone on to champion the methodology.

In an iterative fashion, FFS participants conducted learning experiments on comparative (conventional vs. IPM) small plots to fill knowledge gaps and to identify opportunities for reducing external inputs while improving production and overall productivity. After two seasons, results in three communities were impressive. Through improved management and use of alternative technologies, such as Andean weevil traps, late blight resistant potato varieties, specific and low toxicity pesticides, and careful monitoring before spraying, farmers were able, for example, to decrease pesticide sprays by half while maintaining or increasing production. In learning plots, the amount of active ingredient of fungicide applied decreased by 50 percent, while insecticides used for pests that had commonly received the highly toxic carbofuran and methamidophos decreased by 75 percent and 40 percent, respectively (Barrera et al., 2001). Through diverse cost reduction tactics, farmers increased productivity in test plots by an average of 36 percent. This experience made clear that the problem at hand was not a lack of alternatives. Nevertheless, we also began to realize that participatory methods alone were not enough to enable change. Attention to policy matters was called for.

Advocacy and policy reform

While all agreed on the severe effects of pesticides, the Eco*Salud* staff participated in considerable debate over acceptable degree of advocacy on the behalf of communities. The research team initially felt that its only obligation was to inform communities and policy makers, with the Ecuadorians more reluctant than the foreigners, likely because the national scientists expected to continue their professional careers in Ecuador and probably had more at stake. Meanwhile, the development team felt that political matters, especially ties between SESA, the government plant health inspectorate with the mandate of pesticide regulation, and the pesticide industry, would prevent change and argued for more aggressive action. Following a visit by pesticide industry representatives who downplayed the severity of the situation in Carchi and placed the responsibility on farmers, the Project Leader concluded that it was time for re-evaluating the conventional, non-interventionist role of researchers.

After consulting with the project staff and the directors at CIP headquarters and INIAP, we decided that it was our responsibility to play a more vocal role in informing the public and advocating stronger regulation of pesticides. The development team developed a series of radio announcements and educational programs that were broadcast throughout the North. Eco*Salud* linked with strategic partners, such as a consortium of development organizations working in Carchi and the local chapter of the Pesticide Action Network, to advance common concerns. In addition, project staff held numerous private meetings and seminars with government officials and industry representatives and it organized public forums.

In May 2001, Eco*Salud* organized a national conference in Quito to present results and policy recommendations. Following practices for hazard reduction recommended in the industrial hygiene literature (Plog et al., 1996), a priority policy recommendation was the elimination of the class of pesticides that were causing the neurobehavioral damage in Carchi: WHO Class I or highly dangerous products. The development team lined up statements of support from government and non-governmental agencies. Pesticide industry representatives from the United States, Central America, Colombia and the city of Guayaquil, where most Ecuadorian chemical companies are based, arrived in Quito days before the conference to meet with the organizers and relevant government officials. Instead of requesting to learn more about the studies and recommendations for improving the situation, they seemed to lobby against the veracity or relevance of the research findings. They expressed concern about the recommendation for eliminating WHO Class I pesticides and persuaded the Director of SESA and the President of the National Pesticide Technical Committee to not support that measure. In fact, despite having a central role in planning the forum and after confirming his participation, the Director of SESA did not show up until after the conference was concluded.

Regardless, representatives from diverse FFS in Carchi travelled to the capital to attend the forum and made convincing presentations on their tested alternatives for substantially reducing dependency on the problematic products in question: carbofuran, methamidophos and mancozeb. They requested governmental attention to the Carchi declaration and a National Pesticide Committee proposal. Officials from the Public Ministry of Health and the Pan-American Health Organization committed to play a more active training, monitoring and advocacy role similar to other projects in Central America (Keifer et al., 1997). The Quito conference led to a television documentary on the pesticide crisis in Carchi that aired throughout the country and subsequently was presented to select audiences in other parts of Central and South America as well as the US and Europe.[6] Despite the receipt of multiple letters from farmer organizations, researchers and development professionals in Ecuador demanding government attention to the situation in Carchi, the Director of SESA never responded nor publicly expressed concern.

By the end of project, the Eco*Salud* staff had overcome its most divisive professional differences and matured into a formidable research-intervention team. Unfortunately, as happens with many development initiatives these days, funding ran out and staff moved on to other employment. Complementary projects took over a number of the training activities in the project sites and grew into other regions. This included the training by INIAP of nearly 100 FFS facilitators in Carchi and nearby Imbabura, the transition of FFS to autonomous small-enterprise production groups as well as an expansion of FFS in Ecuador and elsewhere (LEISA, 2003b). In July 2003, INIAP, CIP and FAO published a Spanish language book (Yanggen et al., 2003) that summarized the research and intervention results. In a forum attended by public officials, industry representatives and media, the authors emphasized the need to decrease and eventually eliminate the use of highly toxic pesticides in Ecuador. Subsequently in-depth radio programs and newspaper

[6] *Amargo cosecha* (Bitter harvest), a 20 minute documentary produced by Adolfo Asar of the *Día a Día* Program, first aired in Ecuador in September 2001.

articles repeated the research findings. SESA officials and pesticide industry representatives responded with seeming disinterest over the alarming health impacts and disdain for calls for the removal of the highly toxic insecticides from the market. As per the findings of a BBC World Service radio program that included interviews with government officials (BBC World Service, 2004), pesticide salespeople, farmers, and hospital personnel in Carchi, the official government position had become: "We have established international standards of recommendation and force the pesticide industry to obey those rules," and "We cannot be held responsible for farmers' misuse of pesticides." Despite the evidence of over a decade of research that clearly showed the hazards of pesticide use in Carchi and feasible alternative practices, it became all too clear that effective change would depend on a drawn-out process of lobbying and local action that went beyond the constraints of Eco*Salud*.

Discussion

Complementarity: learning to work together

While personalities were always at play in conflicts, contrasts among our staff were most clearly distributed across disciplinary and professional lines. At a most basic level, the differences between social and natural scientists had to do with subject: people or the environment. The contrasts between scientists and development practitioners most generally were over purpose: research or action. Such differences influenced perceptions and values. Eco*Salud* staff applied at least three distinct problem-solving logics to project concerns, consistent with what Röling (2000) described as instrumental, economic and interactive knowledge domains. Biophysical scientists and medical professionals most commonly apply the instrumental approach that centres on addressing causality through technology development. Economists and business people tend to use an economic approach that looks to utilize market opportunities and comparative advantage as means to addressing problems. The economists commonly rely on technology "transfer" strategies to readjust advantages. Development practitioners most often use the interactive approach. They seek to solve problems through multi-stakeholder participation and negotiated agreement. Table 5.2 summarizes these approaches.

The first two approaches – instrumental and economic – have come to dominate research and development thinking over the last fifty years. The novelty for the Eco*Salud* project was to acknowledge that these alone would not solve the ecosystem health crises in Carchi. The introduction of an interactive approach enabled the project to begin to address relevant social issues behind pesticide abuse, the reliance on highly toxic products, and the associated human health and productivity problems. Eventually, Eco*Salud* found that all three approaches had important contributions to make in achieving healthier ecosystem management, but not without much struggle.

The reality of the pesticide problem struck home during visits to communities, where each of us came across personal accounts of pesticide poisonings. The tragic poisonings of children found at each location were particularly disturbing. Combined with the invisible quality of toxic exposure, the severity of the pesticide problem created a sense of urgency among the staff. Nevertheless, while this may have brought us together at the beginning, common sympathy with communities was not enough for overcoming our differences. In hindsight, we found that a functional internal project environment was needed to mediate regular conflicts among staff. This was enabled through a handful of administrative mechanisms, including:

- Shared project responsibility – From day one, the entire staff participated in project design and planning, including both research and development activities. During workshops, divergent perspectives were elicited and differences accommodated through discussion and negotiation. Research and development team leaders mediated discussions. When differences could not be reconciled, we commonly referred back to the original proposal or the donor's demands.
- Limited financial resources and transparent administration of funds – appreciating Eco*Salud*'s relatively small budget, the project leaders had to creatively pool resources from their organizations and on-going projects. Knowing this, the staff pulled together to conserve resources and to leverage funds with communities and other like-minded projects.
- Open and regular communication – With the exception of the Canadian-based health expert, the remaining project leaders were based at a research station in Quito, where they regularly met during regular monthly meetings and informally over coffee to assess progress and to iron out differences. The Project Leader had won a reputation for 'keeping his door open' and being a good listener. All trusted him, including the field staff from Carchi. For difficult problems, such as personality issues, he was consulted privately. Similar meetings were held weekly in Carchi, though due to the institutional culture of the national partner as well as the leadership style of Director of the field office in San Gabriel, those were more structured and rigid. Often, conflicts were not resolved in Carchi and demanded the attention of the research team and development team leaders. The leaders regularly discussed concerns and altered weekly visits to Carchi to interact with the field staff and help it to resolve differences before they became major conflicts.
- Learning and redesign – while the donor operated by pre-determined annual plans, it was open to revisions. As research results emerged and communities began to contribute ideas to the project, we inevitably discovered new opportunities.

Nevertheless, such administrative mechanisms could not overcome some differences. For example, the dominantly male leadership in Carchi frustrated the female staff, which found difficulty making it heard and respected, despite the quality of their work. One personality conflict between a soft-spoken agronomist and an outspoken feminist lasted the duration of the project, despite endless mediation and efforts to force them to resolve their differences. Sometimes, this tension permeated upwards to the project leadership, playing out between the project's functional research-development divide. We found that the old adage about "locking enemies in the same room and forcing them to work together on a common task" does not always apply. Nevertheless, by shifting their energies to the greater purposes of the project each managed to stay with us through to the end of Eco*Salud*.

Table 5.2 Three approaches to solving problems (adapted from Röling, 2000)

Characteristic	Instrumental	Economic	Interactive
Who?	Biophysical scientists, pest management specialists, medical professionals	Economists, business-oriented partners	Development practitioners, sociologists
Predicament	Lack control over causal factors	Competition, scarcity	Anthropocentric destruction of habitat, lack of control over ourselves
Dynamics	Causation, self-organization of systems	Rational choice, struggle for economic survival, market forces	Interdependence, agency, learning, reasons
Objective	Control or management of nature for human purposes	Win, gain advantage, optimize utility	Negotiated agreement, concerted action
Knowledge base	Natural and medical sciences	Economics	Social science, cognitive science
Effect based on	Technology (agrochemical inputs, biological controls, medicines)	Strategies for technology up-take, market integration	Conflict resolution, agreement, learning
Policy focus	Engineering, hard systems design, regulation	Fiscal policy, market stimulation, technology transfer	Interactive policy making, social process design, dialogues, process facilitation

The combined factors of highly relevant research and a growing appreciation among our staff of its purpose were essential for overcoming biases against quantitative perspectives. For example, early on the development team realized that high quality quantitative information could play an important role in calling attention to pesticide concerns. Similarly, the researchers began to see the potential of gender-sensitive participatory approaches. For example, the women and children, who were brought into the project by the gender specialist, were the populations quickest to respond to the health information. During one meeting, after the men in the room had denied adamantly careless handling of pesticides, one mother pulled a member of our staff aside with a suggestion. She requested cameras to be handed out secretly to the town's kids, who would in turn take photographs of the men misusing products, for example, washing out backpack sprayers in the streams. We handed out disposable cameras and offered to pay for film development. Several weeks later we called together the community and the kids gave a surprise presentation of their photos, much to the embarrassment of the men. This spontaneous activity and others like it were repeated in the other communities and usually were quite successful in getting across the point about problems with pesticides. More farmers and their families volunteered to subject themselves to the health assessments and to take part in awareness raising activities.

Through such interactive cross-disciplinary experience, project staff gained new appreciation for the unique skills of their colleagues and their potential contributions to the project. Such understanding matured by the end of the project, particularly when we shifted energies to engaging policy reform, which led us to confront influential actors, such as the pesticide industry.

Interdependence: engaging policy reform

While the development team was eager to take on advocacy roles on behalf of communities, the researches at first hesitated. The scientists ran a risk when they decided to take a more pro-active stance in informing the public and policy on research outcomes (Sherwood et al., 2002), which could place into question the objectivity of science. Earlier critiques of researcher inaction on pesticide-related policy over a decade earlier in the Philippines pointed out why such risk, while problematic for science, was necessary for change. By the early 1980s, a significant body of research in the Philippines showed similar severe health effects among rural people due to continual exposure to highly toxic pesticides. Nevertheless, as Loevensohn and Rola (1997) explained:

> ...it was not until 1992 that policy decisions were taken commensurate with the scale of damage that research was projecting. These included a ban or severe restriction on a number of popular but highly toxic insecticides and, in 1993, the launch of a nation-wide program of farmer training in Integrated Pest Management (IPM).

The Philippine government regulatory agency and the pesticide industry applied their usual response: SUP training. Local and international industry resisted the prescribed voluntary regulation and safer alternatives. Over time, NGOs and IPM programs separated from the SUP program, contending that pesticide hazards and alternatives to pesticides were not sufficiently emphasized. The international community, especially the International Rice Research Institute, FAO, and international NGOs, missed numerous opportunities to intervene, largely due to organizational rigidity, obedience to standard operating procedures, and diverse forms of self-censorship. The majority of national and international researchers refused to share findings and take stand in public meetings and media programs. Loevensohn and Rola (1997) argued that both international institutions and researchers shared a degree of responsibility for the delay in policy progress:

> There was information that was not persuasively put forward to policy makers that, had it been, might well have advanced the decisions. This would have led to a reduced toll in death and illness, to lesser damage to the aquatic environment, and likely to increased rural incomes. Seizing these opportunities would, however, have required individuals to act in inhabitual ways, outside the mandates of their institutions, and possibly at some personal risk.

Stepping out of their comfortable roles, Eco*Salud* researchers proactively engaged stakeholders in policy debate at both the provincial and national levels. Our position evolved to include the reduction of pesticide exposure risk through a combination of hazard removal (i.e., the elimination of highly toxic pesticides from the market), the development of alternative practices and ecological education. We called for international action on the extremely toxic pesticides (Sherwood et al., 2002; Sherwood et al., 2007). As a result, an unknown source threatened a team member by telephone and industry representatives questioned our research. Fortunately, such attacks were not as strong as those that have occurred to other researchers when publicity about their research has threatened to affect the profits of industry or agendas of other special interest groups (Deyo et al., 1997). We found that such threats had the effect of uniting the research and development teams.

As others (Riggs and Waples, 2003) and we have experienced, private industry often pays greater attention to short-term gains for shareholders, than to the longer-term health of users of their products and the greater public good. The social science research on pesticide use in Carchi substantiates the need for knowledge-based and socially oriented interventions aimed at political changes (Mera-Orcés, 2000 and 2001; Paredes, 2001).

Bugs in the system: encountering structural constraints

In analyzing needed change for management of complex issues such as those associated with social systems and the environment, Röling (2005) mapped out graphically the development of scientific paradigms along the intersections of two axes: positivism-constructivism and reductionism-holism. Here we have adapted this model to emphasize source of knowledge/technology and levels of preoccupation. The "source of knowledge/technology" axis is built on extremes of exogeneity (externally generated) and endogeneity (internally generated). The "level of preoccupation" axis is built on extremes of mono-vision (the control of components or parts) to holo-vision (management of systems or synergies of parts). The interaction of these two axes provides a taxonomy of development (see Figure 5.2).

Different members of Eco*Salud* and stakeholders engaged in pest management in Carchi embodied particular perspectives and could be roughly assigned to different quadrants. Pesticide salespeople and "modern" (i.e., external input intensive) farmers generally approached production problems from joint exogenous-mono-vision perspective and fit into quadrant I. When considering pest problems, this "techno-centric" perspective produced recommendations for "single bullet" solutions, such as the application of pesticides or spraying efficiency. Meanwhile, the researchers at INIAP and CIP – often biological scientists or economists – tended to draw on a combination of exogenous and holisitic perspective when confronting pest management problems (quadrant II). This perspective led to the application of hard science and systems thinking and produced externally designed research and intervention approaches, such as a call for Integrated Pest Management and agroecology practice. Meanwhile, researchers with anthropological or sociological backgrounds as well as development practitioners with similar perspective tended to value interactive endogenous-holistic design (quadrant III). While continuing an emphasis on systems-level complexity, these actors tended to view pest and pesticide dependency as anthropogenic phenomena. Thus, when conceiving interventions, they argued for culturally centred approaches, for example, the local construction of IPM through participatory agroecosystem analysis as practiced in the Farmer Field Schools. The health researchers and professionals straddled all three quadrants. Farmers who were relatively isolated from external technologies as well as local communities tended to develop technologies autonomously and fell into quadrant IV. Röling (2005) argues that successful management of ecosystems requires movement from quadrants I and II to quadrant III, since the later lies at a higher systems level and encompasses the previous two.

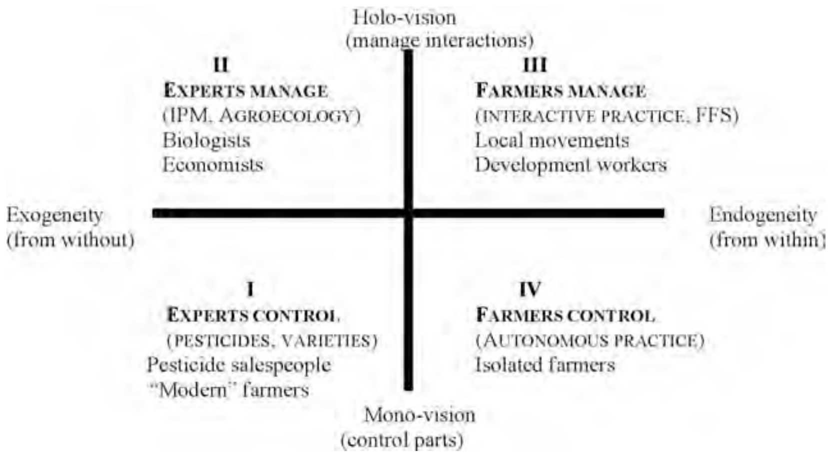


Figure 5.2 Four development paradigms (adapted from Röling, 2005; originally based on Miller, 1983 and 1985; Bawden, 2000)

From our experience, the logics of quadrants I, II, and III were all readily apparent across the staff and differences, such as those presented in Table 1, and commonly played out along the quadrants. Nevertheless, we found that present institutional and policy designs, shaped by the assumptions of exogenous designs, ultimately circumscribed our capacity to apply community-based participatory approaches. Sometimes differences were irreconcilable, such as over the degree of investment of project resources in either technology or process-oriented activities. Commonly, a dominant actor (e.g., the project manager) or political manoeuvring (e.g., through leveraging the donor's priorities) resolved differences. Other times, paradigmatic differences were mediated over the thematic middle ground found in quadrant II, for example, over the relatively neutral theme of IPM. This was where individuals articulated differences during weekly meetings in the form of proposed activities and logistical concerns, encountered divergent views, and made compromises for the good of the project. Nevertheless, overall, the project would sustain a relatively exogenous, expert-centred bias that certainly influenced outcomes.

The success of Eco*Salud* arguably relied upon the leaders' ability to broker interaction among perspectives, especially the success of introducing elements of endogenous design, for example, through people-centred, community-based approaches such as the Farmer Field Schools. While the FFS and similar activities proved to be effective means for enlisting community involvement in the project, ultimately broader structural constraints, such as the training of professionals or the linear designs of development interventions, limited our ability to more genuinely accommodate local perspectives. Based on observed tensions, we envisage the need for a new professional capable of brokering cultural differences among research and development professionals and between external actors and communities (Table 5.3). High quality information will always be a need for measuring and understanding agricultural, health, and environmental concerns, but the way we go about defining and prioritizing questions, conducting, interpreting, and using research is subject to change. The need was for more interactive platforms that effectively brought together diverse perspectives over the common concern. We found that cross-disciplinary research and development practice demanded professionals with generalist academic backgrounds, practical community development experience, and strong facilitation skills.

Table 5.3 Towards more interactive community-based research and development (R&D) (adapted from the ideas of Pretty, 1995 and Leeuwis, 2000)

	Conventional R&D role: producer of knowledge, technologies, and services	**Newer R&D role: facilitator of learning and action and negotiation**
Assumptions on reality	Single tangible reality	Multiple realities that are socially constructed
Interaction with bodies of knowledge	Disciplinary-based, limited interaction with other perspectives	Transdisciplinary-based, on-going interaction and transformation of perspectives
Scientific method	Reductionistist and positivist: Complexity can be best described through independent variables and cause-effect relationships. The perception of the researcher is central.	Holistic and post-positivist: Local and global categories and perceptions mutually acknowledged. Differences between subject and object; methodology and data are little defined.
Strategy and context of research	Researcher knows what he or she wants. Designs are pre-established. Information is extracted from controlled experiments. Context is controlled and independent.	Researcher does not know where the research will go. Themes emerge from learning-action process. Focus and understanding emerge from interaction. The context is fundamental.
Who sets priorities?	Researchers and practitioners give priority to problems and activities.	Communities, practitioners, and researchers prioritize together.
Relationship with intended beneficiaries	Researchers and practitioners control and motivate clients from a distance. Tendency to distrust local people, who are principally research objects.	Researchers and practitioners maintain close dialogue with constituents. Construct trust through joint analysis negotiation.
Intervention modality	Project driven: time and thematic bound.	Programs and social movement driven: unbound, work in teams based on long-term commitment.
Political mandate	Inappropriate: threatens objectivity	Appropriate and necessary: acknowledgement of social role of science

Capable brokers of development cannot operate in institutional vacuums. Greater involvement of local experience will demand support from organizations that can leverage needed structural change. At the very least, externally designed, time-bound projects that presently govern most research and development activity continue to be based on problematic notions of external control and predictability that work against growing appreciation for interactive learning and local participation and ownerships of initiatives.

The ecosystem health approach calls for new ways of thinking, organizing and doing that challenges us to go beyond present institutional designs. While we emphasized cross-disciplinary science, it became clear that what was most needed was a framework that permitted trans-professional, science-development oriented towards greater community accountability. Such movement would require fundamental change towards more locally democratic and pluralistic science and development, which in turn would place new pressures on policy frameworks (Table 5.3).

Conclusions

Differences between the institutions of research and development do much to pull apart researchers and practitioners and little to bring them together. Under the demands of project implementation, professionals from both camps involved in Eco*Salud* were forced to interact and negotiate perspectives. While this interaction sometimes led to unsatisfactory results for some, it also contributed to new skills and understanding between previously disparate perspectives. We found cross-disciplinary research particularly challenging at the field level. Working cultures for staff members (e.g. agricultural extension, participatory research, feminist social change, and health services) were built on different sets of assumptions, methods of resolving conflicts, planning and perceived roles in interacting with project participants. The mediation of such differences sometimes carried high transaction costs.

Through often-difficult processes of negotiation and accommodation, the staff gained insight into differences with their colleagues. With new understanding, staff learned to work in complementary ways that contributed to successful project outcomes, such as more integrated use of research data and participatory methodologies for advancing both science and development agenda. When confronted by external obstacles, in this case over pesticide policy matters, the staff joined force and collaborated around a common agenda for eliminating highly toxic pesticides.

Despite new cross-disciplinary learning and practice, we cannot hide from the fact that the vast majority of rural people in the three communities where Eco*Salud* operated, not to mention the rest of Carchi, continue to be chronically exposed to harmful pesticides and, as a result, suffer neurotoxic damage affecting their productivity and well-being. Regardless of high quality research that revealed dramatic health problems, the conception of effective farm-level alternatives, and extraordinary efforts to communicate those to policy makers and the public, to date very little has been achieved in improving local conditions. We found that fundamental problems of paradigm circumscribed our ability to go further with ecosystem health practice. Moving towards greater science and development accountability to communities takes us beyond present organizational and professional designs and requires a revision of policies, including fundamental change in development and research practice.

Chapter 6

Farmer Field Schools in the Social Wild: Exploring the Limits of Methodology-based Interventions

Summary

Concerned about the increasingly apparent social and environmental products of modern agriculture, I became part of a growing network interested in Farmer Field School (FFS) methodology – a knowledge-intensive, people-centred approach to agro-ecosystem management – as an alternative. Despite well-established farm- and community-level contributions (see, for example, van den Berg and Jiggins, 2007), FFS requires a fundamental shift in the underlying norms and values surrounding agricultural science and development practice that can be at odds with the dominant ways of thinking, doing, and ordering. As such, FFS represented a radical departure in Carchi – the planting of a technological niche innovation aimed at influencing the dominant socio-technical regime.

Drawing on six years of reflective practice, diverse studies, and on-going interactions with FFS graduates, facilitators, and Master Trainers, I explore the introduction of FFS to Ecuador and the subsequent multiple expressions of the methodology after it was released into the hands of researchers, development practitioners, and their organisations – a transformative process I describe as FFS in the *social wild*. I study the spontaneous appropriations of the methodologies, concentrating on how researchers and *técnicos* of the expert system diversely translated and transformed the methodology. I then analyze this experience in light of present calls for "scaling-up" of FFS.

Introduction

Farmer Field School (FFS) methodology has been proposed as a promising novelty for transforming agricultural practice (Kenmore, 1991; Pontius et al., 2002; Luther et al., 2005). FFS is a high-order, interactive learning approach that employs well-established principles of adult education (e.g., discovery-based learning), in-depth knowledge of agroecology (e.g., life cycles of key organisms, plant-pest beneficial interactions), and social organization. Numerous studies have demonstrated the promise of FFS (summarized in van den Berg and Jiggins, 2007), leading a growing number of development professionals, researchers, and policy makers to call for its mass institutionalisation through "scaling up" and "scaling out" (LEISA, 2003a and b). Meanwhile, others have claimed that FFS does not meet their criteria for effectiveness or efficiency (Feder et al., 2004; Davis, 2006), provoking responses (Gallagher et al., 2006; van den Berg and Jiggins, 2007) and controversy.

Research in the Andes has suggested that FFS is far from a homogeneous entity. Over time, actors of government agencies, NGOs, and community-based organizations commonly manage the methodology in different ways, leading to diverse and even contradictory expressions (Paredes, 2001; Mendizabel, 2002; Sherwood and Thiele, 2003; Borja, 2004; Schut, 2006). In his book *Cognition in the Wild*, Edwin Hutchins (1996) explores how cognition performs in its "natural habitat," i.e., in the realm of spontaneous, culturally constituted human activity. Borrowing from Hutchins' metaphor, this paper examines the performance of FFS in the social wild – i.e., its spontaneous transformations following its release into the hands of researchers, development practitioners, farmer leaders, and their organizations.

Based on diverse studies (Jiggins, 2001; Paredes, 2001; Barrera et al., 2001; Mendizabel, 2002; Barrera et al. 2004; Borja, 2004; Maurceri, 2004; Schut, 2006), project documents, field visits, interviews with FFS Facilitators and project participants, and nearly a decade of reflective practice, in this chapter I pursue a single line of inquiry: what happened to FFS in the social wild? Drawing on the literature on socio-technical change and evolutionary economics, I close with conclusions and a wider discussion on how people-centred approaches may evolve from a niche-level contribution to influence the broader trajectory of agricultural development. Before going on, however, I need to provide a conceptual foundation on knowledge production and socio-technical change.

Conceptual matters

Knowledge production in science and development

In their work on knowledge production of science and research in contemporary society, Gibbons et al. (2000) identify an ongoing transformation in practice. They describe two modes: more traditional science based on knowledge produced from within the confines of a disciplinary perspective (Mode 1) and an emerging form of science produced from within the context of application (Mode 2).

Born from classical Newtonian model of inquiry, Mode 1 production of knowledge tends to be theoretical and academic. In rural development, the "experts" – i.e., scientists – diversely employ this mode from within particular disciplinary contexts – agronomy, economics, health or government. Mode 1 is homogeneous in terms of inquiry and skills employed. It operates from within established and centralized hierarchical structures, with well-defined codes and rules that govern behaviour and how consensus is reached. Preoccupied with producing knowledge that is generaliseable across localities, it is characterized by low local accountability and reflexivity. Instead, its chief preoccupation is upholding disciplinary or professional norms. Quality is enforced through "peer review," with peers selected based on past compliance with norms. This type of production rewards individual creativity only within the limits of established norms. Knowledge is built on past findings and becomes cumulative. Contributions spread through the professions and broader society through spontaneous processes of "diffusion."

In Mode 2 knowledge production is viewed as "people-centred" in that it prioritizes local concerns. It is practical, in that it emerges from the process of localized distributive problem solving. This mode represents a new way of thinking, organizing, and doing. It may involve both experts and practitioners and is transdisciplinary – where multiple and even contradictory codes and rules collide and convene. It is heterogenous, in that it demands diverse experiences and skills, and operates in heterarchical structures – the interaction of mixed and dissimilar organizations with necessarily loose and flexible decision-making processes. Consensus is highly conditioned by context and evolves with it. Knowledge is context specific and highly dependent on localities. Mode 2 is characterized by high social accountability and reflexivity. It is demand-oriented and inclusive throughout and highly sensitive to outcomes and impacts. Quality assurance depends on the social composition of the review system, but a central preoccupation is local relevance of outcomes and impacts. The knowledge production process is characteristically distributive. It accumulates through the repeated configuration of human resources in flexible and transient forms of organization and decision-making. Spread occurs during a process of generation and is largely limited to it. According to Gibbons et al. (2000: 1), "The emergence of Mode 2, we believe, is profound and calls into question the adequacy of familiar knowledge producing institutions, whether universities, government research establishments, or corporate laboratories." Table 6.1 compares Mode 1 and Mode 2 production of knowledge.

Table 6.1 Comparison of Mode 1 (expert-led) and Mode 2 (lay or people-led) knowledge production (based on the ideas of Gibbons et al., 2000)

Criterion	Mode 1: Knowledge produced in the context of abstraction	Mode 2: Knowledge produced in the context of application
Nature of knowledge production	Theoretical – produced from within a disciplinary community	Practical – produced from within a problem context
Bias – rules that govern conduct	Disciplinary and multidisciplinary – single or multiple system of rules governing conduct	Transdisciplinary – dynamic, multiple systems of rules collide and collude
Problem-solving – experience and skills employed	Homogeneous – focused, well defined experience and skill set	Heterogeneous – diverse experiences and skills involved
Organization structures	Centralized and hierarchical – well-established; graded and top-down	Diverse and heterarchical – loose, flexible, and fluid structures; mixed and dissimilar constituents
Negotiation and consensus – resolution of differences	Closed and static – conditioned by pre-established norms and rules	Open and transient – conditioned by context of application and evolves with it
Nature of knowledge	Generaliseable and cumulative	Context specific and dependent on locality
Social accountability and reflexivity	Low – offer oriented, exclusive and low sensitivity to impact of outcomes; preoccupied with internal criteria and priorities	High – demand oriented, inclusive and high sensitivity to impact of outcomes; preoccupied with relevance
Quality control – enforcement of 'good science'	Self referential – peer review judgements; peers selected based on compliance with norms; emphasis on individual creativity from within disciplinary bounds	Broadly based – composite and multi-dimensional; dependent on social composition of review system; emphasizes group think; socially extensive and accommodating
Theory of knowledge spread	Spontaneous diffusion based on merit	Repeated processes of generation

Socio-technical change and the expert system

Van der Ploeg (2003) emphasizes that farmers and their families do not operate in a social vacuum but rather other individual actors and social groups are directly and indirectly involved, each of which may emerge from colluding or diverging activity. Such tendencies in turn produce "constellations of various modes of ordering," interlocking, and collective definitions of courses of action and development opportunities, communities of aligned heterogeneous actors or "socio-technical networks."

Nelson and Winter (1977) described what *técnicos* believed as possible or desirable as producing a "technology regime" and "natural trajectory." Rip and Kemp (1998) explored how otherwise heterogeneous groups of actors involved in science and technology produce patterned ways of thinking and organizing that lead to structural properties capable of enabling and constraining certain activity. Resulting dominant "socio-technical regimes" actively set rules in the form of routines, protocols, norms and regulations through problem definition, informing perspectives, engineering practices, and exploiting niches of development opportunity, thereby guiding behaviour and enabling means of continuity and transition. The regime generates and distributes resources. It creates and implements regulatory frameworks that affirm or marginalize certain pursuits. A socio-technical regime, then, is seen as both a factory and a storehouse of rules and the organisation and employment of resources for the production, use, and regulation of technological processes and products.

Drawing on biological metaphor to explain the evolutionary processes of socio-technical change, Schot and Geels (2007: 5) propose, "They [socio-technical regimes] perform the task of genes and define the boundary between technological species." While genetic crossing through sexual reproduction does not exist in socio-technical regimes, heterogeneity and "selection" emerge through dynamic interactions of the regime, both from within and without its rule structure, opening up "niches" of opportunity for change and transition. They emphasize that niches must not be viewed as a market or resource void waiting to be filled, but rather the product of social agency. Niches emerge into the socio-technical environment as constructions. Niches either represent differential growth within the regime (a "market" niche), thereby contributing to its slow and steady development within the evolving rule set, or they emerge from without the rule structure (a radical "technological" niche), thereby representing a potential de-stabilising force of discontinuity (Levinthal, 1998). In the case of radical technological niches, tensions are generated, leading to different forms of responses. Individual or collections of firms may raise doubts over whether or not established norms and rules are being followed, or they may seek opportunity in taking the risk of joining an emergent network. Based on perceptions of priorities, governments and other actors might encourage or discourage certain tendencies and movement. Over time, developments from within the emergent niche, attractive novelties, new rule sets and organisation may emerge to challenge and replace the existing order.

Van der Ploeg (2003) explains that during the second half of the twentieth century a dominant socio-technical regime became built on an expert system and its modernisation project. In agriculture, it was characterized by the industrialization of production, especially reliance on external inputs and markets. While this "expert system" first emerged in the industrial countries, it quickly spread across social and geographical space to influence agricultural development across the planet.

An expert system in Ecuador emerged as part of this globalising phenomenon, informing and shaping a particular trajectory of development. Emerging with the land reform policies of the mid-1960s, Article 22 of the 1989 Ecuadorian Law of Agrarian Development provides a clear articulation of what became a dominant view on agricultural development: "Agricultural research will elevate the productivity of human and natural resources through the generation and adoption of technologies of easy diffusion and application with the objective of increasing production…." Accordingly, a socio-technical regime has organised around the "generation" and "adoption" of technologies, assuming that research will enable the increase of production and productivity, leading rural people to fulfilment and satisfaction in life. This regime has come to set standards and regulate "best practice," i.e., innovations that increase the coherency, efficiency or prestige of the established order. As we have seen in previous chapters, in agriculture, standards emerged as norms for crop and variety selections, total tillage, planting dates and densities, and crop management practices. Through means of control, such as determination of efficiency and effectiveness criteria and the distribution of resources, the regime in Ecuador has systematically come to legitimise proposals that resonate with its established ways of thinking and doing. Thereby, it marginalizes others deemed less efficient or relevant. Similar to elsewhere, the socio-technical regime in Ecuador actively uncovers and promotes as well as hides and conceals.

Competing proposals of development

In northern Ecuador, as elsewhere in Latin America, the roots of agricultural modernisation date to land reform, which was followed by government policies aimed at "technification" of production through specialised, external sources of innovation, particularly information and technology (Barsky, 1980). As such, the socio-technical regime that emerged in Ecuador came to value the role of technical specialists or experts, while farmers became seen as relatively passive actors with limited knowledge and in need of assistance. Exchange of information and technologies became mediated through currency and markets, and decisions were based on instrumental logic, such as economic cost-benefit (i.e., monetary costs vs. monetary gain) (Barsky, 1984). The central preoccupation of expert-led, "technology-centred" development became: what people don't do and how to get them to do something new, for example to adopt a particular innovation, such as an agrochemical product or an Integrated Pest Management (IPM) package. Since under this paradigm of thought initiatives were largely pre-determined, approaches became amenable to external manipulation through relatively closed projects with tight budgets, timelines, and administrative controls.

As Beck (1992) and Giddens (1990) explain, the contradictions of industrial era development, especially the degradation of natural resources and heightened social vulnerabilities, give birth to new movements. In rural development practice, during the

1970s, an alternative proposal to the technology-centred, expert system emerged around diverse notions of user-centred, participatory, endogenous development, or people-centred development.[1] Instead of relying on outside experts to provide information and solutions, people-centred development seeks to engage people in a continuous search for local novelties as seedbeds of change. Thereby, they value farmers as highly knowledgeable and capable of solving problems on their own. Rather than through currency and markets, people-centred development emphasizes the mediation of ideas, experience, and commodities through social relationships. Highly dependent on local perceptions and creativity for outcomes, people-centred development demands highly iterative and open-ended learning and action processes, where it is essentially impossible to predict outcomes or timelines. To be effective, people-centred interventions require a great deal of common understanding with individuals and their communities, e.g., knowledge on what people do and why. Much attention is provided to relationships, historical analysis, negotiated agreements, and concerted action. Table 6.2 summarizes characteristics of technology and people-centred development.

Table 6.2 Conceptual comparison between people- and technology-centred development

Characteristic	Technology-centred development	People-centred development
Primary source of change	Exogenous – induced through specialized, usually external, sources of information and technology	Endogenous – induced through localized contingency and on-going practice of living
Knowledge	Expert – specialized and highly standardized, quantifiable, preoccupation with rigor and objectivity	Lay – general and highly diversified, qualitative, highly subjective
Time	Discrete – bound with beginnings and ends	Indiscrete – not divided into parts or separated
View of local actors (e.g., farmers)	Passive – limited knowledge and in need of assistance	Active – knowledgeable and capable of solving problems
Exchange	Commoditized; mediated through currency and markets	Non-commoditized; mediated through social relationships
Logic behind decisions	Monetary costs vs. monetary benefits	Nurturing social relationships
Preoccupation	Adoption – What people don't do; work to get people to do something differently	Common understanding – What people do and why; work with people to advance common agenda

Farmer Field Schools as a locus for radical change

Farmer Field School methodology emerged in large part as a response to the adverse consequences of modern rice farming in Asia, especially the health and environmental effects of pesticides (Kenmore et al., 1987). The methodology was based on the premise that farmers were motivated and capable innovators who, provided the insights of biology, could come up with effective solutions to their pest management problems

[1] The Development literature includes diverse forms of people-centred development (e.g., user-centred, learner-centred, participatory, endogenous and farmer-to-farmer development), each with its own histories and nuances. For examples in Latin America, see: Freire (1973 and 1990), Bunch (1982), Holt-Giménez (2006). Other expressions of 'people-centred' development are described in: Chambers (1983), Chambers et al. (1990), Krisna et al., (1997), Uphoff et al. (1998), Haverkort et al., (2002), and Leeuwis (2004).

themselves. FFS accommodated typical learning styles of lay people, such as hands-on, in-the-field learning that was closely linked with the priority crop of interest (Matteson et al., 1994). Over time, the methodology diversified to include new crops, animals, and other aspects of rural life (e.g., market interactions, specialized soil and water management, human health and AIDS) in different geographies and cultures (see, for example, the English and Spanish versions of LEISA, 2003a and b or the examples available at: http://www.infobridge.org/ffsnet).

Rather than provide answers to pre-determined questions, FFS brought together farmers in groups and involved them in discussions over cropping concerns. The methodology strategically aimed to limit information to what farmers don't know (or do), but need to know to improve their agriculture. FFS sought to shed new light on previously hidden agricultural phenomena, for example, over insect ecology and especially pest-beneficial interactions. It employed discovery-based learning experiments to help farmers "see" what was previously hidden, for example over the life cycle of a particular insect of concern. Rather than promote specific technologies, farmer groups systematically tested their own ideas through comparative trials. Box 6.1 summarizes the design features of FFS.

FFS also came to emphasize collective action for addressing increasingly complex community-level social and socio-environmental challenges, what became "Community IPM" (Pontius et al., 2002; Röling and Jiggins, 1998). Van der Fliert (2006) summarizes how FFS aimed to transform conventional agriculture extension. Through positioning farmers as highly knowledgeable, emphasizing social interaction as a means to learning, and utilising iterative learning-action processes, the methodology was an explicit application of Mode 2 knowledge production and people-centred development.

Box 6.1 Learning principles of Farmer Field Schools (based on Gallagher, 1999)

- Non-formal adult education – Adults have substantial life experience and are largely independent, self-directed learners.
- Interactive group learning – People learn best in groups, where they can interact and exchange ideas based on their diverse life experiences.
- Content linked to crop and animal stages/life cycle – Farmers address technical content immediately, as it emerges with the development of the crop or animal and the labour and cultural activities associated with its production.
- The field is the best place for learning – Rural people prefer applied knowledge and learn best during hands-on interaction with their crops and animals in the field.
- Basic scientific concepts – Every farm and every season is different; farmers need to manage general concepts and apply them to specific local contexts.
- Continual learning and experimentation – Agriculture is a highly dynamic enterprise, and as a result, farmers never stop learning and innovating.
- Farmers become "experts" – As a result of the above, participants become critical thinkers, highly capable of independently solving problems and taking on the challenges of their agricultural development.

By design, FFS is knowledge produced through collective problem solving in the local context – with local actors in the field and community. The learning-action process is transdisciplinary in that it addresses the multiple and interactive aspects of agriculture production – soils, plants, pest management, marketing, as well as collective social pursuits, such as the formation of groups, associations, and cooperatives. FFS employs diverse perspectives of farmers and expert knowledge in open-ended discovery. It emerges from organizational processes that are socially mixed and demand extensive negotiations and consensus-building among participants. The end product, for example, the practice of IPM, is not pre-determined, but rather it emerges through the process of problem solving. The specific outcomes of FFS are highly context specific around a given crop, field and culture, and as a result, they are not widely applicable beyond a given locality. Spread of knowledge depends on repeated application in new localities. The context specific, socio-environmentally embedded process of learning and action makes it highly reflexive. The participants demand relevance from day one and outcomes undergo their continual review. In this mode of knowledge production, "good science" is that which leads to learning and practice that responds to felt needs.

FFS represented a departure from the expert system and its modernisation project, as expressed through conventional extension practice (Table 6.3). Instead of experts who provided answers, FFS employed "facilitators" who consulted farmers in process design and guide open-ended learning. According to this model, participants became responsible for conducting experiments and finding answers. Without significant changes to program staffing, resource distributions, and organizational designs, FFS could not be implemented. As a result of its conflict with the established practice, it was inevitable that the methodology was going to provoke strong reactions.

Table 6.3 Comparison between conventional extension and FFS (Pumisacho and Sherwood, 2005)

	Expert-led extension: technology-centring	**Farmer Field Schools: people-centring**
Underlying logic	Instrumental and directed	Organic and interactive
Who chooses content/themes?	Expert/specialist	Participants themselves
Learning content	Narrow and well-defined	Broad and open to questioning
Teaching/learning methods	• Formal lectures • Demonstration • Controlled experiments	• Dialogue • Discovery-based activities • Open-ended experiments
Role of participants	Passive subjects: Collect and memorize what is taught	Active subjects: Question, learn and teach, find solutions
Role of teacher/trainer	Active subject: talk, teach, discipline, determine relevant content, provide answers	Active subject: Facilitate, raise questions, learn and teach, provoke discovery
Primary source of experience	Expert/specialist	Everyone
Who is knowledgeable?	Expert/specialist	Everyone
Communication style	Uni-directional: from expert to participants, limited and controlled	Bi-directional: between facilitator and participants, open and free
How do people learn?	Collecting and memorizing what is taught	Reflection over personal experience
Desired effect on participants	Learn to adopt and manage technology	Learn to analyze and solve problems independently

FFS in Carchi

Between 1999 and 2004, Manuel Pumisacho, from the Ecuadorian *Instituto Nacional Autónoma de Investigación Agropecuaria* (INIAP), and I, at the time a Participatory IPM Training Specialist at the Ecuador field office of the International Potato Centre (CIP), in collaboration with diverse projects and initiatives,[2] spirited the introduction of FFS to Ecuador as well as other parts of Latin America. During that period, we directly implemented Farmer Field Schools, wrote and managed FFS grants, designed and implemented Training of Trainers, coordinated and distributed resources to an emergent network of FFS Master Trainers and Facilitators, and advocated and lobbied in favour of the methodology with public officials. Our approach to FFS is generally summarized in Pumisacho and Sherwood (2000 and 2005) and our general experience is summarised in Luther et al. (2005). In this chapter I commonly refer to Pumisacho and Sherwood as the "FFS project leaders." In 2002, I left CIP and Pumisacho moved on to new projects. While we continued to interact with FFS from a distance, thereafter, neither Pumisacho nor I maintained close contact with the FFS movement in Carchi. I describe the ensuing period as the release of FFS into the social wild.

Arrival of FFS to the Andes

By the early 1990s, FFS became a major methodological thrust in Southeast Asia (Kenmore, 1991). It revealed that insecticide use was largely responsible for pest problems, and it contributed to a broad ban on pesticides for rice in Indonesia. Kenmore leveraged this experience at the FAO, and he convinced countries to develop national FFS programs on rice IPM in the Philippines, Indonesia, Cambodia, Vietnam, and elsewhere. By the end of the decade, Pontius et al. (2002) estimated that over two million farmers of Southeast Asia had graduated from FFS. Kenmore and colleagues established the Global IPM Facility at FAO headquarters in Rome, in part as a means for exporting FFS to other parts of the world, especially Africa and Latin America.

During that period, governments throughout Latin America were well into "economic modernisation," which, in Ecuador, became articulated as the Law of Modernisation of the State (1993). For public agriculture policy, this generally involved the dismembering of public extension and research services and placing the responsibility of development in the hands of private consultancy companies and the agrochemical industry (Beckerman and Solimano, 2002; Gallardo-Zavala, 2003). Similar to van der Ploeg's (2003) description of the Dutch agriculture system, the region's ministries of agriculture, public research institutes, and universities, and the growing agrochemical industry still could be viewed as coherent units. Despite major reorganizations and budget cuts in public systems, a dominant logic of the expert and technology-based change continued to shape and enforce agriculture development. In this context, INIAP was in search of new and creative ways of pursuing its mandate and CIP was charged with supporting its national potato program.

[2] Specifically, EcoSalud/IDRC, FORTIPAPA/COSUDE, PapaAndina/COSUDE, FAO/TCP-ECU0067 and Global IPM Facility, and the Soil- and IPM-CRSP/USAID.

By the mid-1990s, word of the success of FFS in Southeast Asia and similar experiences in Latin America (for example, Bentley, 1992) had reached people at CIP and INIAP in Ecuador through publications, conferences, and often donor demands. By my arrival in 1998, supervisors in Lima and Quito already had decided that "more participation" was called for. My new colleagues expressed frustrations over the shortcomings of past experience with technology transfer. The conclusion among the international and national staff was: "Farmers are not adopting our technologies." I essentially was handed a salary and project resources, and was told to implement participatory research and Farmer Field Schools. Within months of arriving at CIP, contacts at the Global Facility and I began to support FFS as an explicit effort to shift the dominant development paradigm of the Andes towards more people-centred designs.[3]

Agriculture professionals and their organizations in the Andes generally were resistant to ideas from other regions, but they were willing to explore common experience among successful IPM work and to adapt local methods (Thiele et al., 2001; Luther et al., 2005). "Participatory approaches" became a passageway for FFS. In 1997, CIP and its partners in Bolivia and Peru started to experiment with "participatory training" (Torrez et al. 1999a and b), incorporating some elements of the FFS approach, but not the Agroecosystem Analysis (AAE), an activity considered at the heart of the methodology (Pontius et al., 2002). To strengthen the introduction of FFS in the region, in 1999, the Global IPM Facility and CIP led a three-month Training of Trainers course at a MAG centre in Guaslan, Ecuador for 33 professional extensionists and farmer promoters from Ecuador, Bolivia and Peru. The organizers subsequently charged the graduates with the task of introducing FFS in their respective countries.

PROINPA (2001) in Bolivia, Ortiz (2002) and Tenorio (2002) in Peru and Pumisacho and Sherwood (2005) in Ecuador describe the original designs of FFS in the Andes. Figure 6.1 summarizes the methodology's stages and activities. FFS in the Andes aimed to conserve the central features of FFS in Asia. Nevertheless, in the Andes FFS emerged in unique socio-cultural and environmental contexts that posed new challenges.

In the lowlands of Southeast Asia, FFS focused on the stable crop rice. As a result, insect pests, especially the brown planthopper, became a major preoccupation, largely because the environmental conditions of the lowlands favoured the proliferation of insects. Certainly, the fact that entomologists created FFS also deepened a certain insect bias. Meanwhile in the highland Andes, FFS focused on potato and the crop's major phytosanitary concern: the disease late blight (caused by *Phytophthora infestans)*. As a result, in the Andes plant pathologists came to play a central role in the initial application of the methodology. While public investment in agriculture continued in Southeast Asia during this period, as a result of agriculture modernisation in Latin America, the different project and institutional contexts placed unique demands on FFS (Sherwood et al., 2000). Because of a vacuum of public support for rural development, non-governmental actors in Central

[3] As expressed in FAO/TCP/ECU0067 and Sherwood et al. (2000), FFS was proposed in Ecuador and elsewhere in the region as "a means for filling the void" made by modernisation of public services and in particular expert-led agricultural development.

and South America, particularly NGOs and CBOs, were called on from the beginning to play a lead role in coordination and facilitation of FFS (Box 6.2).

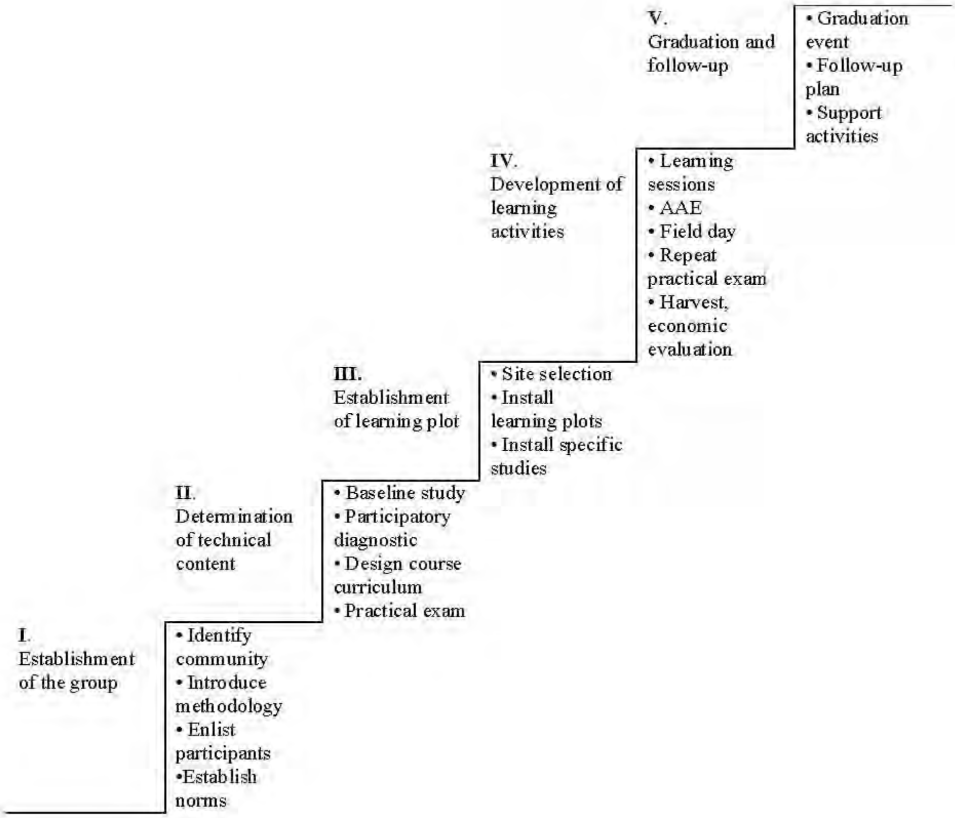


Figure 6.1 FFS methodological process in the Andes (Pumisacho and Sherwood, 2005)

In Bolivia, the PROINPA Foundation and the NGO ASAR took the lead in the design of the initial FFS training curriculum in the country. These organizations closely collaborated to promote the methodology at pilot sites. PROINPA usually assumed responsibility for the research activities and provision of plant material, while ASAR took responsibility for the multiplication of seeds of resistant cultivars and the replication of the experience at new locations. Although the courses incorporated discovery-based learning techniques, farmers had little say in content and design. The preoccupation of these FFS was the "transfer of technology packages." In the learning fields, farmers tested previously validated strategies of chemical control for late blight with resistant cultivars (Navia et al. 1995; Navia and Fernández-Northcote, 1996; Fernández-Northcote et al., 1999). Training came to concentrate on the application of the strategy and related components. Participatory research in FFS largely was limited to evaluation of new cultivars and advanced clones.

Box 6.2 Obvious differences between FFS in Asia and the Andes

In 1999, when researchers and development practitioners began to test FFS in the Andes, potato was the principal economic crop and the one that demanded the greatest use of external inputs. In intensive production areas such as Carchi, farmers spent over $2,000 per hectare on fertilizers, pesticides, tractors, and related labour. FFS in potato IPM contained technical content on the organisms that tended to have a comparative advantage in higher altitude production systems: plant pathogens and resulting diseases, especially late blight (Nelson et al., 2001). The biological motility and aggressiveness of the late blight pathogen limited the usefulness of crop-level cultural controls. Management generally depended on late blight resistant varieties and judicious use of fungicides. As a result, pathologists and host resistance came to play a central role in FFS in the Andes. Additionally, in Ecuador researchers quickly found that mechanized tillage on steep hillsides was a major cause of soil loss, so FFS focused much attention on soil erosion, which was not a concern for lowland rice farmers. Also, potato farmers often over applied synthetic fertilizers. As a result, FFS often emphasized how to increase productivity through the introduction of resistant varieties and reducing fungicide and fertilizer use.

The conditions of the Andes demanded a suite of new discovery-based learning activities. In addition to the FFS experience in S.E. Asia, there was ample experience in Latin America on which to draw (Bentley et al., 1993). While discovery-based approaches had proven useful in helping farmers to manage plant disease (Sherwood, 1997), the microscopic size of pathogens made them invisible to farmers and highly abstract (Bentley, 1989 and 1991), which posed unique problems for agricultural trainers.

Rural demographics were very different between the regions. In Southeast Asia, farmers commonly cultivated much less than a hectare. Meanwhile, in Carchi, they tended to farm three to five hectares. Further, rural people in Southeast Asia tend to live in concentrated communities of thousands of families. The communities of the highland Andes are commonly made up of less than 10-50 families spread out across large areas. This demographic created challenges in bringing together farmers as well as difficulties with communication between sessions. Often participants asked for fewer, more intensive meetings.

The institutional environment of the Andes, especially the role of public agencies, was substantially different than that of Southeast Asia. Andean countries underwent sharp cuts in public investment in agriculture and rural development during the decade of the 1990s. As a result, governments generally were not amenable to large national-level programs such as those that championed FFS in Southeast Asia. Increasingly, short-term consultants began to dominate community development and NGOs and these operated time-bound, project-based contributions. A number of NGO partners claimed that their competitiveness depended on project-based results, implying that staff time had to be continually remunerated. They were not commonly willing to send staff to intensive three-month Training of Trainer (ToT) courses. This led us to shift to semi-presential trainings based on biweekly sessions over periods of six or more months. It also led to an emphasis on market-oriented approaches to financing FFS and farmer-led FFS.

In Peru, CARE became responsible for community-level implementation of FFS. CIP led content design, delivered clones and cultivars, and monitored the data generated as a result in the farmer-run research plots. Similar to Bolivia, these FFS included lively discovery learning activities, but they also emphasized research intensive activities. The FFS became "Participatory Research-Farmer Field Schools" (PR-FFS), a hybrid of the learning intensive designs of FFS and research that targeted scientists' priorities, especially the disease late blight (Nelson et al., 2001). As part of the FFS, farmers conducted trials on disease resistant cultivars and advanced clones as well as the use of varying rates of fungicides. Each FFS lasted two or three years, with emphasis on research during the first cycle and thereafter the progressive transfer of responsibilities to participants and communities.

In Ecuador, we explicitly proposed FFS as a "strategic people-centred response" designed to help local actors "overcome the challenges of modernisation."[4] MAG, INIAP, and CIP positioned FFS as "…. an effective response to the on-going privatization of public services and decentralization of the state, which places the agenda of agricultural development in the hands of local governments, NGOs and the communities themselves." We sought to draw on FFS as a means of institutionalising a "farmer-to-farmer" approach and proposed the establishment of new communication linkages between networks of farmer promoters and development practitioners and scientists. Partners proposed to increase local agricultural knowledge, described as "ecological literacy," through experience in FFS and subsequently to support intensive technology development by means of research groups composed of FFS graduates as well as *técnicos*[5] and scientists from a collection of rural development agencies, research institutions, and universities.

Emergence as "best practice"

As a result of the startling research outcomes on the problems of modern potato production in Carchi (Chapter 2), CIP and INIAP's agenda became centred around the improvement of farm productivity and rural health through decreasing dependence on agrochemicals. Following the Tradeoffs research that prioritised IPM and a pilot FFS in San Francisco de Libertad in 1999, FFS in potato production became the prescribed way forward.

Our first goal was to demonstrate the potential of FFS, so we started off by designing a thorough documentation system (described in Borja, 2004), and we commissioned impact studies. Organisations supporting FFS have used diverse approaches to assess the methodology's impact (van den Berg, 2004; van den Berg and Jiggins, 2007). Due to the time limitations of the projects in Carchi, we chiefly employed before and after evaluations of learning on key IPM concepts and cost-benefit analysis from the learning plots

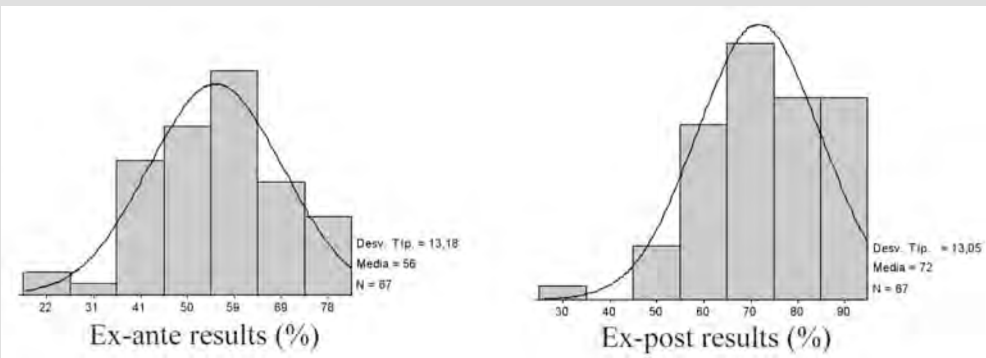
[4] See "Development of the Innovation Capacity in Integrated Pest Management and Production (IPPM) for Greater Food Security in the Ecuadorian Highlands," FAO Technical Cooperation Project (TCP/ECU0067) that INIAP, MAG, and CIP conducted between November 2000 and October 2002.

[5] In the Andes, as elsewhere in Latin America, the title *técnico* or *ingeniero* is applied to a class of academically trained professionals generally holding a four-year, BSc- or sometimes MSc-level technical degree in agronomy or a field of engineering.

(conventional vs. IPM comparison plots) (Barrera et al., 2001). Subsequently, as a growing number FFS were completed, colleagues conducted ex-post studies to assess longer-term considerations, such as technology adoption and adaptation (Barrera et al., 2004; Mauceri, 2004; Schut, 2006).

With initial support from the Eco*Salud* and FORTIPAPA projects, during 2000 we conducted a new round of pilot Field Schools in Libertad as well as Cuba and Piartal to demonstrate the potential of FFS in three geographic centres of potato production in Carchi. Results from the "ballot box" tests showed that FFS helped farmers to significantly increase their knowledge of relevant ecological principals (Box 6.3). Economic data from the FFS comparison plots demonstrated how farmers could substantially decrease agrochemical use (including synthetic pesticides and fertilizers) without decreasing production by area (Table 6.4). Through cost-benefit analysis, we argued that FFS graduates could decrease production costs for a tonne of potatoes by about 30% (from $104 to $80), leading to arguments that wide scale application of FFS could generate a 25 percent gain in efficiency that would carry on year after year. We drew on selected studies from other regions, especially 25 world-level studies summarised in van den Berg (2004), to further substantiate such claims. We searched opportunities to share these data in public appearances and publications, and we utilized the information in requests for further investment in our projects.[6]

Box 6.3 IPM learning: before and after results of "ballot box" evaluations in Carchi



Farmer Field Schools in Carchi employed before and after ballot box tests on knowledge of key biological and ecological concepts deemed essential for IPM, including information on soil conservation and fertility management, seeds, varieties, pest and diseases, and beneficial organisms, as well as productivity and marketing concerns (Pumisacho and Sherwood, 2005). Results were used to make claims on the impact of FFS on participant learning (for examples, see Sherwood et al., 2003; Barrera et al., 2004).

The arrival of additional FAO project resources brought on board the Minister of Agriculture, who assigned members of the National Directorate of Investigation and Technology Transfer (DITTE) to support the "institutionalisation" of FFS in Carchi and

[6] For examples, see Sherwood et al. (2003 and 2005).

elsewhere. In practice, this involved the creation of minimum standards for FFS graduates and facilitators as well as the establishment of a database on approved Field Schools.[7]

Table 6.4 Cost-benefit analysis of learning plots from three Farmer Field Schools (USD/ha) (Barrera et al., 2001)

Community	**Cuba**		**La Libertad**		**Piartal**	
Plot	**IPM**	**Standard**	**IPM**	**Standard**	**IPM**	**Standard**
Direct costs:						
Soil preparation	42	94	68	85	38	47
Planting	233	183	289	136	220	220
Fertilization	261	334	266	272	246	388
Labour	120	105	50	81	110	110
Phytosanitary controls	276	362	139	213	133	183
Harvest	167	237	119	227	180	180
Storage	21.60	22	18	18	22	22
Land rent	80	80	80	80	80	80
Total direct	1,199	1,417	1,030	1,112	1,027	1,229
Indirect costs:						
Interest (18%)	216	255	185	200	185	221
Unforeseen (5%)	60	71	51	56	51	62
Admin. (5%)	60	71	51	56	51	62
Total indirect	335	397	288	311	288	344
Total costs	1,534	1,813	1,317	1,423	1,315	1,574
Harvest (kg)	23,406	17,953	15,680	14,342	18,000	18,000
Price (kg)	0.23	0.23	0.20	0.20	0.20	0.20
Gross profit	5,383	4,129	3,136	2,868	3,680	3,680
Net profit	3,849	2,316	1,819	1,445	2,365	2,106
Cost/benefit ratio	3.50	2.28	2.38	2.02	2.79	2.34
Return	250%	128%	138%	102%	180%	134%

As part of the FAO project, in 2001, Pumisacho and I formed a coterie of facilitators to champion FFS in northern Ecuador and elsewhere (Luther et al., 2005). We supported an intensive 400-hour Training of Trainers for 35 farmers and *técnicos* from the northern Ecuadorian provinces of Imbabura and Carchi (26 people completed the training). Most of the participants were from public organizations (INIAP, MAG, municipal governments and technical schools), national NGOs, and community-based organizations (communities and farmer cooperatives). Four were from private consulting firms and agrochemical companies. To accommodate the diverse demands of our partners, we expanded the technical platform around "Integrated Crop Management" (ICM). Similar to the Asian approach to IPM, ICM emphasized soil fertility through managing soil life, limited tillage, cover crops and green manures, multi-cropping, rotation schemes, and minimal use of synthetic fertilizers. The FFS in ICM were primarily applied to potato, but

[7] Borja (2004) describes this system.

to deepen the penetration of the methodology, we encouraged partners to apply FFS to other crops and animal systems, including field beans, tomato, Andean grains (quinoa and lupine), onion, pasture/milk production, guinea pigs, and chickens.

By the end of 2001, positive results from ex-post evaluations on the first round of Field Schools began to arrive. Studies found that a high percentage of FFS graduates adopted IPM technology, especially resistant varieties and insect traps, enabling many to substantially decrease pesticide use (Paredes, 2001; Barrera et al., 2004). Farmers said they welcomed the methodology as a refreshing change to the "theory" and "impractical" recommendations of *técnicos*. A number of graduates expressed that they had felt abandoned by the government and were eager to work with people who were willing to spend time with them in the field and learn about the difficulties they faced, which were not always limited to production agriculture. While some farmers were impatient with the open-ended, discovery-based learning of FFS (i.e., having to find answers on their own), they favoured the exposure to "new technologies," such as seed and varieties as well as information on pests. Overall, studies found a positive trend in learning of key concepts and innovation. Participants liked that FFS facilitators treated them as equals. As a result of their enthusiasm, FFS graduates became the best salespeople of the methodology.

During meetings and presentations, Pumisacho and I continually referenced the contributions of FFS in Southeast Asia, and we cited the FAO and World Bank as important international organizations that were committed to the approach. We translated materials and showed videos of farmers and *técnicos* in Indonesia and Cambodia who advocated on behalf of the methodology. Presentations were made in numerous public and private organizations in Carchi and the capital as well as dozens of communities. We claimed that FFS was the "wave of the future" for agriculture extension. Additionally, colleagues at the FAO's Global IPM Facility in Rome lobbied on behalf of our proposals to assure that our projects received full consideration.

We found that data were not enough to fully "sell" the methodology. Many officials, researchers, and development practitioners asked for more concrete evidence. In response, we sent outstanding FFS graduates to the capital so that they could provide personal testimonies on the value of the methodology. We aggressively searched opportunities for FFS graduates to make impressive demonstrations of their knowledge during public seminars, congresses and other forums. We arranged for them to appear in newspaper articles as well as on the radio and television. We felt, however, that further legitimacy only could be gained by taking the bureaucrats and politicians to the field.

FFS methodology included a field day, a daylong event when participants organized six to ten thematic stations to present learning and the outcomes of experiments and other activities. Often officials and *técnicos* who were uninformed about the methodology were reluctant to participate, so Pumisacho and I made a habit of meeting officials at their homes in the capital and personally driving them to events in the provinces. At first, this included the heads of CIP and INIAP, and later, the directors of potential partner organizations and donor agencies. We strategically included officials from government agencies, such as SESA, the Ministry of the Environment and of Public Health as well as the FAO and the Pan-American Health Organization. We learned to leverage field days for maximum benefit. Many events included more than 500 people, including leaders from communities where the FFS initiative wanted to expand as well as politicians, researchers, donors, and the media.

Studies on field days found that, after listening to FFS participants explain the details of their experiments on the life cycle of an insect or the response of a crop to particular fertilization regime, for example, attitudes towards FFS and farmers substantially changed (Borja, 2004). *Técnicos* were observed pulling out paper and taking notes. At the end of the day, we commonly placed officials in front of the crowd of participants and handed them a microphone. Their public comments included: "I did not think that farmers were capable of learning so much in so little time," "We *técnicos* can't even tell the difference between virus and bacteria," and "Today was a major coup for farmers." These statements were recorded on video and repeated during our public appearances. Field days became a powerful political device.

In addition, we regularly sent FFS graduates to influential national and international meetings held throughout Latin America. As an example, one outstanding FFS graduate participated in a regional, FAO-sponsored meeting on food security that took place in Guatemala. During the event a high-ranking representative from Ecuador's Ministry of Agriculture claimed that his World Bank-financed PROMSA project had made important contributions to Carchi. "With all due respect," interrupted the farmer, "not even a single penny of your project has found our communities." He went on to argue, "Only the FFS have made a difference." Later, the farmer presented his FFS experience, which a representative from the FAO later described to me as, "The hit of the meeting." Such impressive public displays of knowledge helped make FFS a prestigious symbol.

As project leaders, Pumisacho and I did not overlook the motivations of *técnicos* who came on board with FFS. While the FFS initiative usually did not have ample resources for direct financial rewards, we drew on other forms of payment. Not unlike the pesticide industry (see Chapter 7), we held planning meetings at attractive resorts on the coast and in the Amazon. Those who trained FFS facilitators were provided status as "Master Trainers." We created new opportunities for our colleagues to publish articles and training materials. We sent the media to interview them about their work, and their names appeared in newspapers and television. The most outstanding Master Trainers travelled to Bolivia, Colombia, Nicaragua, El Salvador, Honduras, and eventually Angola and Mozambique for months to support other initiatives. In summary, we actively sought attractive opportunities for collaborators, and we leveraged those to advance the FFS agenda in Carchi and elsewhere.

By 2003, dozens of farmer groups requested technical support for implementing FFS. Mayors and the head of the provincial government in Carchi regularly mentioned Field Schools in their public addresses. The regional head of MAG cited that through FFS his office was promoting the "cutting edge of agriculture extension," and he formally requested assistance in commandeering international financing for Field Schools. Representatives from national and international pesticide companies contacted the project leaders in Carchi to see how they could support FFS. The methodology had become part of the spontaneous political discourse of key players of the socio-technical regime in Carchi. Arguably, within five years of its introduction, FFS obtained the prestigious status of best practice.

Release into the social wild

In April 2001, I optimistically told a team of external reviewers from Global IPM Facility, "Thanks to FFS, we are well on our way to instituting people-centred development across private, public, and community-based organizations in Ecuador – particularly in northern Ecuador." In its report, the team of reviewers acknowledged the presence of diverse organizations, however, it expressed a foreboding concern over what it saw as "weak institutional commitment."[8]

CIP and INIAP eventually trained over 50 facilitators in northern Ecuador from a plethora of organisations, including national NGOs (CEDERENA, Randi Randi, EcoPar), universities and agricultural schools (Pontificate Catholic University of Ecuador and the Martinez Acosta Agriculture School), networks (the Carchi Consortium and MACRENA), local governments and public agencies (Municipality of San Gabriel, the Provincial Government of Carchi, the Ministry of Agriculture (MAG), and the National Institute of Agriculture Research (INIAP)), graduates of FFS from numerous communities and farmers organizations, and the FAO's Food Security (PESA-E) and Community Forestry (DFC) programmes. In addition, a handful of these facilitators became Master Trainers (i.e., those in charge of training trainers), who went on to conduct ToTs in other areas of Ecuador as well as elsewhere in the Andes (Colombia and Peru), Central America (El Salvador, Honduras, Nicaragua, and Guatemala) and Africa (Mozambique and Angola). Table 6.5 highlights major events associated with the introduction and expansion of FFS in northern Ecuador.

Our objective of introducing FFS seemingly achieved, in 2003, Pumisacho and I turned our attention to new challenges. Pumisacho took on new training contracts on the coast and in Honduras, and he began to focus on new areas of learning, especially the creation of agri-food chains and producer networks. I left CIP to begin my PhD research at Wageningen and took on part-time work as a technical advisor with World Neighbors. Later Pumisacho and I discovered that multiple and sometimes contradictory utilisations of FFS would emerge to fundamentally transform the methodology, placing into question the ultimate contribution of FFS as a means to advancing people-centred development and enabling farmers to address concerns over pesticides.

[8] GIF. 2001. Mid-term review of the Global IPM Facility. J. Jiggins (team leader). April-June. FAO, Rome. 71 pages plus annex.

Table 6.5 Major events associated with the introduction of FFS in northern Ecuador

Date	Event
August-September 1999	Guaslan, Chimborazo Training of Trainers – First regional ToT in the Andes, including 35 participants from Bolivia, Peru, and Ecuador
October 1999	Provincial forum on health, productivity, and environmental impacts of pesticides
September 1999-March 2000	First pilot FFS in Carchi: CIP and INIAP conducted FFS in potato IPM in the villages of La Libertad, Santa Martha de Cuba, and San Pedro de Piartal, Carchi
October – December 2000	Master Trainer from INIAP-Carchi sent to support first FFS ToT in Central America in collaboration with the FAO and PROMIPAC
November 2000	Beginning of two-year FAO-funded project to introduce FFS to the Ecuadorian highlands
February – June 2001	First ToT in FFS methodology in N. Ecuador – Led by INIAP and MAG in collaboration with CIP; 26 graduates (2 women and 24 men), including 6 farmers
2001	Implementation of 13 pilot FFS in Imbabura and Carchi (potato, field bean, pepper, and tomato)
May 2001	National forum on health, productivity, and environmental impacts of pesticides
July 2001	Master Trainer from MAG-Carchi sent to support FFS ToT in Colombia in collaboration with CORPOICA
2002	Implementation of 10 FFS in Imbabura and Carchi (potato, field bean, pepper, tomato, and agroforestry)
October 2002	FAO-sponsored FFS project ends; Pumisacho and Sherwood shift attention to new, non-FFS related challenges, representing the release of FFS into the "social wild"
February – October 2003	Second ToT in FFS methodology in N. Ecuador. Focus on potato IPM; led by MACRENA; 18 graduates (6 women, 12 men)
2003	Implementation of 10 pilot FFS (field bean, potato, Andean crops, commercialization) in Imbabura
April – May 2003	Master Trainer from MACRENA sent to support FFS ToT in Guatemala (coffee)
2006	Association of Promoters for Integrated Community Development (APRODIC) established
November 2006	Master Trainer from MACRENA sent to support FFS ToT in Perú (guinea pig/cuy) in collaboration with Heifer and World Neighbors
December 2006-February 2007	Master Trainer, Max Ochoa of MACRENA, sent to support FFS ToT in Angola and Mozambique in collaboration with the FAO

Diverse expressions

Field schools meant different things to different people. A characterization based on farming styles (i.e., culture, labour processes, and decisions about technology and markets) in Carchi found that FFS were more attractive to certain social groups than others (Paredes, 2001). The most enthusiastic participants belonged to two groups: the highly pragmatic and inquisitive farmers and landless labourers. The first group was motivated by its interest in the FFS alternatives that allowed them a certain degree of independence from capital and input markets (credit and agrochemicals). The landless labourers, on the other hand, were primarily motivated by the unique opportunity to co-invest in production, which effectively afforded them access to land, as well as by more egalitarian treatment during training sessions. Meanwhile, Field Schools appeared to be of less interest to others. For example, the high risk takers, who commonly depended more on the capital and agrochemical input markets for potato production and who readily adopt (and abandon) technologies, as well as intermediate farmers, who tended to co-invest for production, were generally frustrated by the knowledge-intensive orientation of FFS methodology.

Andean farmers do not operate alone in isolated farming domains. Rather, they are part of unique socio-technical networks in which other actors, organizations and entities collectively inform and define courses of action and development opportunities (van der Ploeg, 1993). As a result, for farmers as well as *técnicos* perceptions of the meaning and value of FFS respond to a certain way of defining relevant problems and solutions within a socio-technical network. Paredes (2001) explains that certain farming styles operate in networks in which pesticides came to be accepted as obligatory or unavoidable elements of good potato farming - despite the risk they represent for a family's health. In other styles, less agrochemical use was desired to avoid risks, and, in this case, good farming also meant safe farming. This perspective helps to explain why different actors may find different meanings and opportunities in FFS and how those influence the appropriation of the methodology.

Between 2005 and 2006, Schut (2006) conducted research on the diverse expressions of FFS in northern and central Ecuador. Over a period of six months he participated in on-going Field Schools, lived with families of graduates, and accompanied facilitators during their daily activity. Drawing on a cognitive interpretation of framing theory (Gray, 2003; Aarts and van Woerkum, 2005), he documented the multiple applications and adaptations of FFS. Schut (2006: 135) concluded:

> In practice I found that different actors have various frames on FFS, its fundamental elements, methodological process and roles of participants and facilitators (theories). Also the frames on how FFS can contribute to agricultural problems in Ecuador (perception of the problem or context) differed between actors. Sometimes frames of different people within the same institution were divergent or even contradictory. Individual actors used different frames within different situations to justify their behaviour, decisions and actions…. I observed that actors' cognitive frames sometimes showed ambivalence with their actual behaviour and actions, which created confusing, contradictory situations within FFS. I discovered that actors had different reasons and goals for working with FFS methodology.

To illustrate the diverse expressions of FFS in Carchi, I present the contrasting experiences of three FFS facilitators: Joel, an agronomist from a public research institution (INIAP), Lenin, a forester from a conservation NGO (EcoPar), and Eduardo, a leader from an organization of voluntary farmer promoters (APRODIC).[9] How did FFS diversely undergo changes in the hands of these actors and their organizations?

Case 1: Joel at INIAP: the national agriculture research service

Joel was from a small rural town that was taken over by Quito's urban sprawl during the oil boom of the 1970s. He grew up in a rapidly urbanized Kichwa-speaking community. His grade school teacher was proud of the agricultural roots of the town and taught the students about gardening and fruit trees. Joel applied much of his learning at home. His

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[9] I have changed the names of individuals involved in this case study.

family raised crops and vegetables and reared chickens and pigs to feed itself, while their income came from his father's irregular employment as a factory or construction labourer in the city. Joel said with conviction, "That teacher and at home is where my passion for agriculture was borne."

Joel was the best student of his class in high school. He studied animal science at the *Universidad Autónoma Nacional* and conducted his thesis on pasture systems in Chimborazo with INIAP. Following graduation, INIAP hired him for a permanent extension-researcher position, and he was sent to support the Unit of Validation and Transfer of Technology in Carchi. As Carchi was the most intensive potato production region of the country, INIAP's activities there centred on the crop's production problems. Joel conducted applied research on varieties resistant to late blight. He researched IPM of the Andean weevil and the leafminer fly. He also conducted research on crop response to chemical fertilizers. In 1996, he was sent to CIAT in Colombia, where he was trained in the CIAL methodology. In 1999, we selected Joel, who had become a leader in the Eco*Salud* project on pesticide health effects, for the first FFS Training of Trainers at Guaslan.

Joel described the ToT as an "awakening." He was greatly impressed by Iv Pherun, a Cambodian who had studied in Cuba and became the Head of the National IPM Programme. Given his knowledge of FFS and Spanish language skills, the FAO chose Pherun to lead the first ToT in the Andes. Joel said that Pherun's "commitment and passion for IPM impressed the entire group." Joel became a champion of FFS and earned the fame of being one of the country's best facilitators.

As the provincial head of INIAP-Carchi, Joel came to coordinate many projects, including FORTIPAPA, IPM-CRSP, and Eco*Salud*. Each included FFS as the lead intervention platform. In 2001, Joel organized and led the first Training of Trainers for *técnicos* and farmer leaders of the north. In the evaluations the participants gave Joel a perfect five out of five star ranking in: enthusiasm, teaching, example, and friendship.[10]

In a workshop leading up to the Ecuadorian methodological guide (Pumisacho and Sherwood, 2005), Joel expressed concern over the "erosion of FFS." He emphasised that a Field School was not a Field School if it did not include: "the agroecosystem analysis, learning plot, insect collections and zoos, and experiments." He lobbied for the creation of a test to assure that facilitators and graduates met minimum standards of both the technical aspects of IPM and the process management aspects of FFS. Once during a field day Joel pulled me aside to tell me that he felt the participants did not own clear knowledge of the agroecosystem analysis and that their experiments lacked creativity. Joel developed a reputation as a staunch advocate of FFS-by-the-book.

Citing Pherun's example, Joel actively resisted collaboration between INIAP and the pesticide industry. When he left for two years of graduate study, however, his supervisor

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[10] Final report to the Government of Ecuador. FAO. 2003. "Development of Innovation Capacity for IPM and Agricultural Innovation for Greater Food Security in the Highlands." Technical Cooperation Program/ECU/0067, 22 pp.

at INIAP in the capital took advantage of his absence to establish a new project with CropLife, which involved placing an industry representative inside the field office in Carchi. Thereafter, INIAP's approach to FFS underwent a strong transformation. After Joel returned in 2004, he told me that he had been forced to implement a "hybrid of the FFS methodology." A farmer FFS facilitator who collaborated with Joel told me that the outcome shared little in common with original Field Schools. The new approach involved five modules that centred on getting farmers to adopt an "IPM technology package." The farmer explained that the content was pre-determined, and there was little time for learning plots, agroecosystem analysis, and experiments. Despite Joel's early clarity and enthusiasm over the methodology, organizational constraints led him to implement technology-centred Field Schools.

Case 2: Lenin at EcoPar: an environmental NGO

Lenin grew up in a small city of southernmost Ecuador. His parents had rural roots, but like many youths of his era, Lenin's aim was to become a professional and move out of the *campo*. The nearby *Universidad Nacional de Loja* had a highly demanding forestry programme, known as the best programme of its kind in Ecuador, which immediately attracted Lenin. Later, the FAO's Community Forestry Program (in Spanish, DFC) hired him as an agroforestry extensionist to work in Chimborazo, about four hours north of his home. A group from his hometown led the DFC, and Lenin fit right in. He was trained in "cutting edge participatory methodologies" and became part of the FAO's largest program in the Andes that was one of the FAO's most lauded initiatives.[11] The Dutch organization, ETC, played a central role in informing DFC's methodology, centring heavily on extensionist-led rural diagnostics, participatory planning and implementation, and monitoring, evaluation, and follow-up. One of his supervisors at DFC described Lenin as "young, smart, and hardworking – one of our best community extensionists." Nevertheless, the FAO eventually ended the project in the early 2000s. When the private consulting firm EcoPar won an IDRC grant to implement a biodiversity conservation project in Carchi, many former DFC employees were hired, including Lenin.

Midway through his career, Lenin completed an MSc in Community-based Natural Resource Management at the Catholic University. He was one of the best students in the class. Of the subjects presented in the diverse curriculum, Lenin told me that economics made the most sense to him. His thesis on environmental services argued for forest conservation through different forms of resource privatization and administrative procedures to monetize relationships between urban- and rural-based people. He felt that provided the financial incentives, farmers would protect their land and watersheds for the people of the cities.

In 2004, the Training Coordinator of at EcoPar – an avid proponent of people-centred development and social learning – assigned Lenin to attend an FFS Training of Trainers in Otavalo, which focused on "Integrated Potato Management." She told me that she was concerned about Lenin's "vertical" teaching style. She said, "Lenin likes to spend as little

[11] The Community Forestry Program approach in the Andes was amply described in Kenny-Jordan et al., 1999.

time as possible in the *campo*, and he tells farmers what they should do." She believed that this approach was having little impact. Lenin told me that he attended the ToT reluctantly, explaining: "The DFC prepared me in participatory methodologies. The [FFS] training was very basic and not always relevant to me." Nevertheless, he said, "The technical training in potato IPM is new and useful, since I am working in Carchi." Further, EcoPar's donor agency, IDRC, was enthusiastic about participatory development approaches such as FFS, so he had decided to learn the methodology.

Following the ToT, EcoPar proposed a series of FFS as a means of building a grassroots initiative around the themes of biodiversity and conservation of the forest remnants on the eastern Andean ridge of Carchi. Lenin was placed in charge of implementation. Technical themes included ecological potato production, soil conservation, and forest management.

According to his colleagues at EcoPar, Lenin immediately adapted FFS to fit his own understanding of best practice. He decided not to work with larger groups but rather individuals, and he chose the dates and times of meetings. He did not involve participants in open-ended curriculum design. Instead he pre-determined technical content and process. His FFS did not include the central process elements of the methodology. When I visited the communities where Lenin worked, participants described having learned technical content associated with making a home garden and controlling pests. They had not participated in the open-ended, group learning normally associated with FFS. Independent of the ultimate contributions of his activity, Lenin's utilization of the methodology involved the transformation of FFS from people- to technology-centred designs.

Case 3: Eduardo at APRODIC: a community-based organization of farmer promoters

Eduardo's parents were resource-poor immigrants from Colombia who, in the 1960s, crossed the border into Ecuador in search of work. His father became a member of the "24 of May Cooperative" that in the early 1970s demanded land rights from the Bretania Hacienda in El Angel, Carchi, under the national land reform policies. Following a violent conflict, the national government stepped in and awarded land to the cooperative members. Eduardo told me that he remembered growing up in a makeshift hut, high in the *páramo*. One of his stories stood out in my mind: "One day, when my parents had left me all alone to take care of the house, I watched helplessly as a puma captured and ate a sheep. As a five year old, there was nothing I could do. I locked myself in the hut and cried and waited for my father to come home." Eduardo summarized his childhood as, "cold, wet, and lonely."

Such was the weather when I first met Eduardo in his community on a rainy December night in 1999. His father Humberto, his younger brother Luis, and Eduardo were three of the 18 participants in our first pilot Farmer Field School. They did not stand out in the initial meetings. I remember them as polite and quiet. Over time, however, the creativity and enthusiasm of the brothers began to set them apart. They enjoyed the experimentation component of FFS and immediately collected a number of insects that they reared at home and studied. They enthusiastically reported back to the group impressive details on the mating practices of the Andean weevil, the number of eggs laid and hatched, and they fully reconstructed the insect's lifecycle. They designed their own studies, for example, on "how far an Andean weevil adult walks in a day." Eduardo collected "sick" Andean weevils and isolated strains of entomopathogens that he cultured in makeshift sterilized bottles of Norteño (a fermented sugarcane-based alcohol) and rice as a growth medium. They conducted independent studies on resistance to late blight of different local potato varieties. They were not your average people.

Since he did not own land of his own, Eduardo applied his skills to his family's farm. Within a year of the FFS his family stopped using highly toxic pesticides, and they decreased by 50 percent their use of fungicides for late blight (from an average of four to two applications per season). His learning was not limited to the potato crop. Eduardo set up a tree nursery of native species that they used to reforest the boundaries and steep hillsides of their property. They set up contracts with the municipality and NGOs to sell trees for their reforestation programs. Eduardo and Luis experimented with irrigation and pasture varieties and mixtures, which led to substantial improvements in milk production. One of his cows produced about 24 litres of milk per day, nearly three times the average of his neighbours.

Joel selected Eduardo to participate in the 2001 Training of Trainers. Joel explained that while the *técnicos* struggled under the applied technical content of the FFS, Eduardo's intelligence and his earlier FFS experience enabled him to stand out among the group of 26 trainees. Often, Master Trainers would draw on Eduardo to explain the process aspects of the methodology as well as technical content, for example, on insect and plant ecology or the practical aspects of managing a healthy potato crop in Carchi. When I visited the ToT, I was struck by Eduardo's new confidence. He was no longer shy and quiet. Instead, he had grown confident standing up in front of a group and defending his ideas. A potato specialist at INIAP who was a training mate with Eduardo in the ToT confided, "No one knows how to grow potatoes better than Eduardo."

Prior to the end of the ToT, Eduardo had set up an FFS on IPM with gradeschool children in his community. Later, he organized FFS with adults on integrated potato management as well as on how to manage pastures. When I visited several of his FFS sessions in 2005, I observed that Eduardo applied the central elements of the methodology: the participants determined the content, there were comparison plots, people conducted experiments, and they implemented agro-ecosystem analysis.

Eventually, Eduardo went beyond merely implementing FFS. He became involved in the Humanist Farmers Movement, where he promoted the methodology and helped to set up an organization of FFS promoters and researchers in Carchi – The *Asociación de Promotores de Desarrollo Integrado de la Comunidad* (APRODIC). Eduardo told me that the purpose of APRODIC was "to make a difference." Initially, APRODIC hoped to receive financial support from the second phase of the CIP-run Eco*Salud* project to run Field Schools, but for political reasons, CIP decided to channel resources to the Ministry of Agriculture, municipalities, and the Provincial Government, even though those entities had little to no experience with FFS. Nevertheless, those organizations did not live up to their project agreements, so eventually CIP resorted to contracting Eduardo and APRODIC. Eduardo was charged with an FFS in another community, as per an imposed curriculum centring on pesticide safety. When I asked Eduardo about this FFS, he told me that when hired by CIP, "I have to follow their curriculum, which is Safe Use of Pesticides." He added, however, "When I run an FFS myself, I do it the right way – according to what the people want." Table 6.6 summarizes how Joel, Lenin, and Eduardo diversely applied FFS.

Table 6.6 Three expressions of FFS

Characteristic	Joel at INIAP	Lenin at EcoPar	Eduardo at APRODIC
Professional background	Diligent *técnico* – locally-based agronomist with specialization in biological pest control	Development bureaucrat – urban-based forester with specialization in resource economics	Eccentric farmer – lifetime of practical experience with potato-milk farming in Carchi
Reason for learning/applying FFS	Idealistic to pragmatic – "improving lives" was later supplanted by supervisor's interests	Pragmatic – "told to do so" by supervisor and donor	Idealistic – "wanting to make a difference" and pragmatic when working with projects
Facilitation style	Open and interactive	Closed, top-down	Open and interactive
Preferred location of sessions	In the field and classroom	In the classroom	In the field
Source of funding for salaries and FFS	State and external donors (COSUDE, USAID, CropLife)	External donors (IDRC)	Self-financed by facilitator and participants; punctual contributions from municipalities and external projects (Eco*Salud*).
Technical platforms	Potato IPM (adoption of technologies), Safe Use of Pesticides	Agroforestry, sustainable biodiversity, organic agriculture	Potato IPM (pesticide use reduction), pasture improvement/animal management
Number of participants	10-15	1-5	15-30
Average number of sessions	Decreased from 15 to 6	5 informal meetings	15-20, depending on group (primary school students or adults)
Who decides technical content	*Técnico*, in line with project objectives, some consultation from participants on details	*Técnico*, in line with project objectives	Participants, with feedback from facilitator or employer
Use of Agroecosystem Analysis?	Yes and no; full discussion	No	Yes; full discussion and negotiation
Experimentation?	Yes and no; largely pre-planned and project determined	No	Yes; highly open-ended and spontaneous
Didactics	Lively and fun: Dynamic but largely unidirectional	Formal: Lectures, unidirectional learning	Practical: Discovery-based learning, learn by doing in the field
Follow-up	Dependent on project funding	Dependent on project funding	Dependent on group enthusiasm

Learning from FFS in the social wild

> 'Tis but thy name that is my enemy;
> Thou art thyself, though not a Montague.
> What's Montague? it is nor hand, nor foot,
> Nor arm, nor face, nor any other part
> Belonging to a man. O, be some other name!
> What's in a name? that which we call a rose
> By any other name would smell as sweet;
> So Romeo would, were he not Romeo call'd,
> Retain that dear perfection which he owes
> Without that title. Romeo, doff thy name,
> And for that name which is no part of thee
> Take all myself.
>
> – Juliet, from Shakespeare's Romeo and Juliet, 1594

Shakespeare's Juliet makes the argument that what matters most is not what something is called, but what it is. Following my experience with FFS in the social wild of Ecuador, I would add: what something is (or should be) depends on who is asked.

FFS came to mean different things in the hands of different people. After obtaining status as a prestigious symbol, FFS became widely employed. To understand the contributions, potential and otherwise, of the approach, one must look beyond the use of the term and examine how the methodology became diversely utilised. At the onset of this chapter, I posed a single line of inquiry: what happened to FFS in the social wild and why?

<u>What happened to FFS?</u>

The Farmer Field School methodology became diversely appropriated. Adaptation to local context – themes of interest, field conditions, and cultural practices – was generally consistent with its proposals. Nevertheless, changes to process management and didactic design – i.e., the people-centred elements – revealed conflicting expressions of FFS.

According to standard FFS practice, the participants chose the thematic platform. Further, through participatory needs assessment, the facilitator and the participants work together to determine technical content. In practice, however, these factors commonly were pre-determined in Carchi. In Joel and Lenin's cases, their projects in IPM and biodiversity conservation, respectively, conditioned the resulting FFS. When CIP's Eco*Salud* project hired Eduardo the resulting Field School shifted to its priority – Safe Use of Pesticides. Only when Eduardo organized his own, self-funded FFS did he consult participants on the thematic platform and curriculum. When I asked Eduardo about why he let participants define the technical content of these Field Schools, he responded, "When I run my own FFS, I don't have snacks or lunches to offer participants. If they [the FFS participants] do not like the content, why should they show up?"

FFS required participants to identify priority research concerns and to design simple, comparative farmer-led experiments. Nevertheless, I observed that professional biases, projects, and organizational priorities commonly pre-determined the content and design of experiments. In Lenin's case, no experiments were used. In Joel's case, experiments were used to "sell" INIAP's IPM alternatives, especially resistant varieties, fungicide spray regimes, and Andean weevil traps, as well as CropLife's priority: "appropriate" or "correct" use of safety. In the Eco*Salud*-financed FFS, no farmer-led experiments were included. In Eduardo's Field Schools, the participants determined their own experiments on themes such as potato varieties, planting distances, and organic versus inorganic fertilisers.

According to Pontius et al. (2002) in Asia and later Pumisacho and Sherwood (2005) in Latin America, the Agroecosystem Analysis (AAE) is at the heart of FFS methodology. It involves teaching farmers how to "read" the health and ecology of a crop, to take samples of relevant indicators – plant growth, disease incidence and severity, pest-beneficial insect populations, presence of weeds, and moisture conditions, and to report and discuss findings with the group. Rather than rely on expert advice, the negotiated outcomes of the AAE lead to management decisions on how to assure a "healthy" crop based on the experience of the FFS collective. Initially, Joel applied AAE in all of his Field Schools, and he asked insightful questions that forced participants to take good measurements and to address contradictions between their findings. Nevertheless, the hybrid FFS that he came to design and implement de-emphasized AAE. In some cases, the activity was no longer applied. According to one farmer participant, "The goal [of Joel's FFS] is to get farmers to adopt his improved practices." Similarly, Lenin used an AAE activity in one session and then never repeated it. He told me that he felt that it took too much time, and that he could already predict the outcome beforehand. In contrast, Eduardo drew heavily on AAE in all of his FFS, and he challenged participants to look for ways of decreasing reliance on inputs, especially of highly toxics pesticides and synthetic fertilizers. Joel's original utilisation of AAE was more nuanced and sophisticated with biological details, such as the name of certain insects and their habits, but Eduardo's group spent considerable attention to measurements and time for discussion and negotiation. When I asked Eduardo why he emphasized participant decision-making in his FFS, he responded, "They [the participants] have invested a lot of money in the [FFS] plots. I'd be *lynched* if the experiments failed."

The didactics of FFS are based on discovery-based learning (i.e., open-ended, self-directed learning through solving problems) and learning by doing (practice and repetition). Instead of answers, the facilitator employs lively learning experiments where participants discover for themselves not just new technical content but also how to resolve problems independently. Rather than academic, classroom lectures, FFS emphasizes in-the-field exercises where participants learn through the practice of agriculture. Joel invented numerous creative, discovery-learning activities. On multiple occasions I observed him masterfully apply "What is this?" – an elicitive approach to helping farmers find answers to their own questions. He continued to apply lively teaching in his hybrid FFS, but rather than biological and ecological principles, the content shifted towards "correct" employment of technologies. Lenin's colleagues told me that he refused to apply discovery-based activities and that he preferred to give lectures. They said, "Lenin is a *forestal* [i.e., a titled forestry professional or *técnico*]; he doesn't like to dirty his hands." Eduardo, on the other hand, had limited formal education, and he was uncomfortable writing or talking in front of a classroom. He much preferred to be in the field. He told me, "The *azadon* [the hoe] is my best friend." As a result, his FFS took place almost entirely in the field. Eduardo was judicious with the use of discovery-based learning. "When a farmer is testing me, I'll give him an answer so that he knows that I am a *true* potato farmer. Otherwise, he has to find it [the answer] for himself. Sometimes my answers will not be his answers. Each potato field is different. That's where the *ingenieros* make mistakes."

Joel, Lenin, and Eduardo applied FFS methodology diversely. Of the three, only Eduardo continued to allow participants to determine content, to use AAE, farmer-led experiments, discovery learning, and learn-by-doing, but this only occurred when he was free of project constraints. In process management and didactics, both Joel and Lenin excluded participants from determining the thematic platform, content design, decision-making, and independent learning. Be it due to project and organizational constraints or individual preferences, in the hands of these two *técnicos*, FFS became transformed from a people- to a technology-centred endeavour.

<u>Why did FFS undergo transformations?</u>

Competing modes of knowledge production

With the growing application of FFS, we began to observe diverse expressions of the methodology. Many of its defining principles – interactive design, open-ended discovery-based learning, learning by doing, AAE, and farmer-led experimentation – became vulnerable to translation. As Paredes (2001), Mendizabel (2002), Borja (2004), and Schut (2006) all describe, FFS progressively acquired diverse and even contradictory meanings.

After visiting the first wave of FFS throughout Central and South America, Sherwood and Thiele (2003) expressed concern over the "methodological erosion" of FFS (Box 6.4). At the time, we felt that often this was the result of incompetence (faults in our training) or project constraints, such as a thematic demand, time limitations, and funding.

Visiting the FFS in Carchi during 2005, nearly two years after we had departed, Schut (2006) explored the nuances of these developments. He observed that such tendencies repeated themselves across crops, technical platforms, geographies, and institutional settings. He observed that previously competent facilitators (i.e., those who were acknowledged in project documents as fully applying the methodology) no longer applied FFS in its original, people-centred form. This led him to argue that this tendency was no mere oversight but rather the result of patterned behaviour. Schut found that certain elements of FFS highly resonated with the agenda of the socio-technical regime. For example, researchers and *técnicos* appreciated its ability to "reach farmers" and the platform it provided for "enabling technologies to arrive to communities." Nevertheless, other elements, particularly those associated with independent learning and decision-making and open-ended and iterative design proved more problematic. Over time, it was the interactive, discovery-based features of FFS (i.e., those elements that made FFS a people-centred methodology) that captured the attention of the experts.

Box 6.4 Early observations on the transformation of FFS in the Andes (summarized from Sherwood and Thiele, 2003)

- Group establishment – Women were systematically excluded. FFS leaders were chosen on the outset based on criteria external to the FFS experience. In most cases, FFS changed leaders over time.
- Technical content – Facilitators commonly pre-packaged technical content, as per their professional backgrounds and project priorities.
- Learning plots – Often competitive between farmers and facilitators. Sometimes there was no comparative "traditional" plot. Often limited to demonstration of "improved technologies."
- Discovery-based learning – Facilitators commonly cut corners on learning. Instead of facilitating open-ended learning experiments, facilitators often gave lectures in classrooms.
- Experiments – Facilitators often pre-determined content and design. Researchers often introduced complicated designs.
- Follow-up – Project priorities determined follow-up. This central feature was commonly neglected.

The experience of FFS in the social wild illustrates how competing processes of Mode 1 (expert-led) and Mode 2 (lay or people-centred) knowledge production can lead to conflict during the pursuit of rural development. Viewed as a social construction, knowledge is not produced in a vacuum. New claims of knowledge are judged in reference to established forms. This is particularly true for interventions that represent entirely new ways of thinking and organizing. Those that do not conform may be subject to challenge and marginalization. Gibbons et al. (2000: 2) argues: "It seems to be a recurrent historical pattern that intellectual innovations are first described as misguided by those whose ideas are dominant, then ignored, and, finally, taken over by original adversaries as their own invention." FFS faced similar fate.

The process intensiveness of FFS led people from INIAP, MAG, the pesticide industry, and elsewhere to challenge the methodology as expensive. After the benefits of FFS became overwhelmingly clear and the methodology became legitimized as "best practice," many of the very same actors began to claim ownership of it. In the process of taking over, however, FFS became transformed. Schut (2006) found that the facilitation of open-ended discovery learning often became specialised top-down lectures. Questions became answers. The content and processes of FFS were simplified to the point where differences between individual FFS were lost. Consistent with the design features of expert systems, FFS underwent degrees of homogenization (table 6.1). Rather than broaden Mode 1 production of knowledge to accommodate the necessary conditions for Mode 2, we observed that the experts and their organizations commonly sought to transform FFS, so that it became more consistent with their priorities. In the process FFS as Mode 2 became

Mode 1 – knowledge production through abstraction. Was the transformation of FFS due to a simple oversight, questions of competence, or were deeper forces at play?

Expert-led transformations

Mendizabel (2002) explored how researchers at CIP and its national partners drew on FFS for advancing science-based contributions to agricultural development in the Andes and Southeast Asia. In so doing, FFS became hybridized to "Farmer Field Schools-Farmer Participatory Research" (FFS-FPR). This involved shifting technical content around research priorities, such as pesticide-use efficiency (Torrez et al., 1999a and b) or selection of late blight resistance varieties (Nelson et al., 2001; Ortiz et al., 2004). Due to the demands of science, researchers commonly increased the complexity of single variable demonstrations to the point where FFS began to include dozens of variables and other subtleties. As a result, the outcomes of FFS experiments could only be seen through sophisticated statistical analysis. As described in Nelson et al. (2001), researchers commonly conserved the use of discovery learning exercises, but participants commonly were excluded from the selection of thematic platforms and curriculum content. In certain cases, researchers strategically dropped central FFS decision-making tools, such as the Agroecosystem Analysis, and their feedback into activity. In thematics, content and process, researchers commonly transformed FFS.

The priorities of researchers, however, were not the only factors influencing FFS. As a *técnico* from a conservation-oriented NGO, Lenin never fully appreciated the relevance of FFS. He argued that "participatory research" offered a better balance between the demands of participation and his time limitations as an urban-based professional. His Field Schools included smaller groups, fewer encounters, and no Agroecosystem Analysis. This expression of the methodology shared the features of FFS-FPR. While disciplinary demands often constrained CIP and PROINPA researchers, Lenin altered FFS design for reasons associated with his individual perspective – specifically the perceived high costs of participation. Despite support and encouragement from his organization, Lenin's thinking and worldview blocked him from implementing people-centred FFS.

Joel, who was charged with both applied research and extension activities at INIAP, faced different obstacles. His supervisor in the capital, who not unlike Lenin, was inclined towards economic rationality and argued against the high costs of "participation." He was quick to cite the work of Feder and other economists at the World Bank (Feder et al., 2004) in support of such claims. He often referred to the research primacy of INIAP and CIP, arguing that extension was a secondary activity. Further, decreases in public funding as a result of government restructuring produced a subsequent need for public-private collaboration (e.g., between INIAP and CropLife), which worked against Joel's immediate interests in Carchi. On multiple occasions, central government policies intended to combat corruption interfered with FFS. For example, one morning Lilian, the Eco*Salud* gender specialist, called me to inform that the police had arrested Joel and impounded the project vehicle. As a result, they were not be able to support an FFS session in La Libertad. Later we learned that the national government had passed a rule forbidding public employees to use public vehicles over holidays and weekends, exactly when communities preferred to hold meetings. Organizational constraints, such as the preferences of supervisors, mandates, private funding, and public policies, combined to work against Joel's interests in people-centred FFS.

Meanwhile, Eduardo, an independent farmer who lived in a rural village, escaped many such constraints. This was particularly true when he was able to finance FFS through local resources. Eduardo's challenges were more localized, such as how to work together with neighbours to advance what were perceived as common interests. In the expert-led examples, particularly when Joel was coerced into running technology-centred FFS, the central objective was on "what people did not do" (e.g., adopt certain agroforestry or IPM practices) and "how to get them to do something differently" (Table 6.2). This primacy often had little to do with the priorities of farmers. In Eduardo's example, the preoccupation was with "what people did and why" and how to keep participants interested in wanting to learn and work together. When Eduardo conducted the externally funded FFS on pesticide safety, he could no longer conserve this orientation. As a result, he could no longer motivate FFS participants to make financial contributions, and he had to draw on new incentives to get people to attend meetings, such as attractive lunch breaks or baseball caps. Through the freedom of self-employment, however, Eduardo owned a substantial degree of manoeuvrability allowing him to implement people-centred FFS and, to a large degree, conserve the methodology's central design feature: local relevance.

Many experts chose not to relinquish their position or control over resources. Arguably, the broader proposal of FFS as a farmer-led movement was never seriously entertained. During a public meeting, one public extensionist complained, "If farmers begin to lead FFS, then what are we [the *técnicos*] supposed to do?" Instead, the experts and their organizations objectified FFS from human and social development to technology transfer and economic development. Impact studies (e.g., Barrera et al., 2004 and Mauceri, 2004) came to de-emphasize potential knowledge and social contributions while emphasizing environmental and economic ones, especially net return. In such cases, the objective of FFS shifted from "the empowerment of individuals and communities" to "profit in the market." The overall effect was that FFS became transformed to the point where participants moved from the source of innovation to imitating the experts.

Once safely in the hands of the experts, FFS became diversely packaged and sold. It appeared in proposals as means to "organic" or "clean production" (e.g., by INIAP and EcoPar), "pesticide-use reductions" (CIP), and "increases in productivity" (IPM-CRSP). The expected outputs of FFS became part of an individual or organization's marketing strategy. Researchers, *técnicos* and their organizations reduced FFS from a participant-led, multi-faceted and iterative learning-action methodology to a relatively pre-determined and standardized means of technology transfer. The methodology became a simplified object: a packaged course. In the process of creating the object, FFS was re-shaped into a new form: one essentially in line with the norms of the expert system.

In the social wild, FFS was vulnerable to competing forces involved in knowledge production. This was particularly true during processes of going to scale with the methodology. Diverse institutional factors – including professional thinking and preferences, project-based constraints, organizational culture, and centralized decision-making – combined to create obstacles for FFS. Through processes of objectification and commoditization, the methodology became de-localized and de-humanized. After the experts gained control over FFS, it became transformed into an approach that no longer seriously threatened established ways of thinking and doing. Meanwhile, local FFS facilitators, such as Eduardo, enjoyed conditions shaped by their geography and culture that better positioned them to employ more people-centred forms of FFS.

Wider lessons for people-centred proposals

Anthony Giddens (1990) and Ulrich Beck (1992) explain how the contradictions of modernity give birth to new forces of change. Similarly, the negative consequences of the expert system in agriculture may provoke institutional innovation favourable for the viability of people-centred approaches. As a result of the shortcomings of the dominant forms of science and research, Gibbons et al. (2000: 140) argue, "We believe that Mode 1 [knowledge production through abstraction] will eventually become incorporated into Mode 2 knowledge production [through the practice of application] and that the dynamics on which it rests will continue to unleash further institutional change." While, as I argued earlier, the tensions between Mode 1 and Mode 2 knowledge production produced a cooption of FFS methodology, there was nonetheless evidence of institutional confrontation and, perhaps, movement.

I observed a number of counter-tendencies underway in Ecuador that are generally described in Gibbons et al. (2000), including: growth of multi-functionality, more pluralistic science and development, increasingly fluid communication and practice, and a preoccupation with relevance. The fact that certain scientists at CIP invited me to introduce more participatory approaches demonstrated a growing appreciation for change. On the surface, this movement appeared to be in favour of conditions for Mode 2 (lay or people-centred) knowledge production (Table 6.7). Nevertheless, the experience of FFS in the social wild suggests that the sum of conditions ultimately continued to enforce Mode 1 knowledge production.

The proposal of regime change towards people-centred designs was ambitious. It implied transformation of assumptions about the underlying causes of poverty and environmental degradation, "best practice" and "good agriculture," and how people should learn and organize for development. The performance of FFS in the social wild exposed the limitations of methodology-based contributions and especially the utility of "going to scale" with such methodologies as means to changing present techno-centric trajectories. Drawing on diverse literature on socio-technical change (Nelson and Winter, 1977; Rip and Kemp, 1998; Geels, 2004), technology management (Rosenkopf and Tushman, 1994; van de Ven and Garud, 1994), and evolutionary economics (Potts, 2000; Schot and Geels, 2007), I go on to explore how FFS, as a radical niche-level proposal, may come to influence regime configuration and technology. Based on my experience in Carchi, I observed at play three interactive processes of innovation: the shaping perceptions and expectations, learning and the construction of a new body of knowledge, and growth through multi-functionality.

Table 6.7 Institutional conditions favourable to Mode 1 (expert-led) and Mode 2 (lay or people-led) knowledge production

Factor	Mode 1: expert-led science	Mode 2: people-led innovation
Knowledge	Specialized – produced in the context of abstraction	Distributive – produced in the context of application
Role of science	Produce basic knowledge and spin-offs, set priorities – separation between science and technology	Facilitate innovation – little difference between science and technology
Preoccupation of science	Conformity to discipline and truth	Local relevance and accountability
Expected products	Solutions – answers to questions	Process management – management of interchanges
Criteria for recognition	Disciplinary knowledge, compliance to norms	Multi-functionality, adaptability and responsiveness
Communication	Formal, controlled, limited sources, and coherent	Informal, open, multiple sources, and complex
Access to information	Achieved through position	Achieved through social connections and networking
Organizational structure	Rigid, with stable boundaries	Fluid, fuzzy and porous boundaries
Role of government	Promote competition	Promote competition and cooperation

Shaping perceptions and expectations

Over the years, we have learned that more important than the effects of modern agriculture can be people's perceptions. We drew on FFS to enable communities to address latent pesticide concerns, particularly the severe health affects due to chronic exposure to highly toxic pesticides, among other concerns such as soil erosion. Upon arrival, however, it was clear that agrochemicals were not seen as a problem but rather a solution. A first task became helping farmers and the general public to change their perceptions.

As described in Sherwood et al. (2005), through the interactive learning-action process of FFS, the communities of Carchi increasingly uncovered unwanted environmental, health and economic products associated with modern farming. We found that people needed to discover for themselves the "bads" of their agriculture before they could begin to understand the shared responsibility that farmers, communities, and broader society held in co-producing those consequences.[12] Nevertheless, as we experienced with Lenin and Joel's supervisor at INIAP, many experts did not share the vision of people-centred FFS. Working with local perceptions was not enough. We also needed to reach the professional brokers of development.

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[12] The 'reflexive modernisation' and 'risk society' literature views the 'externalities' of modernity, in fact, as an 'internality' or systemic product of societies. As such, socio-technical development in recent times is seen to lead to not just 'goods', but also 'bads' (see, for example, Giddens, 1990; Beck, 1992)

According to Pacho Gangotena, organic farmer and founder of the agroecology movement in Ecuador, "In order to change their reality, people first must change their dreams."[13] FFS needed to become part of a growing movement to inform new visions. Through the FFS experience, people – local farmers and experts alike – needed to shape new hopes and aspirations for the future. Nevertheless, people do not merely fill visions. Visions must supplant other visions, which involves politics and implies power relationships.

The socio-technical regime produced contradictions in Carchi, but perceptions were, in part, clouded by what Latour (1987) and Knorr-Cetina (1999) describe as the myths and mythology associated with the modern production of science and technology and what Giddens (1990 and 2004) describes as the peoples' continued willingness to trust the outsiders. FFS will contribute to people-centred change when the public increasingly chooses to see through the myths of technology-centred development, and it reorganizes around emergent aspirations – around new dreams.

We found that changes of perception led to new expectations, and farmers, such as Eduardo, were increasingly willing to voice those. Many communities no longer blindly accepted the recommendations of the *técnicos* from NGOs, the government, and agrochemical stores. They began to demand non-chemical, "organic" means for improving their agriculture. In several cases, agrochemical salespeople were chased out of town. This led to increased demand for FFS. Nevertheless, as a result of the transformation of FFS, it was inevitable that the emergent forms of the methodology would not meet those new expectations.

Building coherent bodies of knowledge

In his study on "science in the making," Bruno Latour (1987) describes truth construction as an interactive phenomenon involving "black boxing" and the translation of prestigious symbols.[14] Latour's black boxes represent the building blocks of myths – belief systems that go unquestioned. These may diverge or come together as a coherent network. In this way, the collective process of black boxing may represent a formidable "engine of change."

The FFS initiative in Ecuador can be viewed as an example of the process of black boxing in the making – an emergent network capable of producing beliefs and belief systems. To the point where FFS became a coherent body of thought, it was capable of penetrating the institutions of farming, science, and development and redefining the incentives for action. At different moments of our experience, especially when we managed considerable project resources and we held tight control over FFS as a prestigious symbol, we managed to

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[13] Personal communication, 26 October 2005.

[14] Latour (1987: 2) borrows the term 'black box', a metaphor that cyberneticians use to simplify highly complex machinery. He explains that, "They draw a little box about which they need to know nothing but its input and output." Many aspects of agro-biology (e.g., insect and disease cycles, 'pests' and soil biota) and agrochemicals (chemical fertilizers and pesticides) are effectively 'black boxed' by science and technology brokers.

convene a growing array of actors. Nevertheless, as FFS left the protected margins of our agenda and entered the social wild, the meaning of FFS became vulnerable to translation and cooption by competing interests. In hindsight, it appears that we may have released FFS too early – i.e., before it's people-centred form took full social hold. Schut (2006) found that by 2005, the FFS network of actors appeared to have divided between two ideological lines: either a "pro-pesticide" or "anti-pesticide" (or "pro-health," as we called ourselves) camp. Earlier, I cited a number of examples of its diverse and often contradictory expressions. The movement had yet to mature into a coherent body of knowledge.

Nevertheless, certain margins were strengthened. Thousands of farmers gained insight into the biological and ecological processes of agriculture. Substantial evidence suggests that, for some, this contributed to fundamental improvements in farming, especially with regard to reliance on external inputs and the stability of production. Large organizations, such as CIP, INIAP, and the FAO, abandoned FFS in its original form. While FFS in Ecuador did not appear to have achieved the sort of organization described in the "Community IPM" literature (Pontius et al., 2002 and www.communityipm.com), arguably collective action was initiated in a handful of communities, local organizations (APRODIC) and networks (MACRENA). This came to include a number of creative "self-financing" projects, such as the production of treelings for sale under contract to municipalities and investment of earnings in collective funds. As a result of ensuing FFS activity, these organizations had established linkages with similar groups operating in Ecuador and elsewhere, such as the national agroecology movement (CEA) and the regional Humanist Farmers Movement. These Field Schools had become part of a common and growing network capable of producing and enforcing, at least to a limited degree, its own rules.

By mid-2007, the few remaining examples of people-centred FFS continued to operate on the margins, but their strong internal organization, self-financing, and diversifying activity suggested that they had gained a social foothold in northern Ecuador and beyond. Seeds of change were planted, but it was unclear whether FFS as people-centred proposal would continue to grow into an increasingly coherent body of knowledge capable of defining and enforcing rules of "good agriculture" and "good development practice."

Growth through multi-functionality: from scale to scope

Attempts to institutionalise FFS have centred on "scaling-up" – i.e., increasing the methodology's geographical and institutional spread, usually meaning its organizational reach (LEISA, 2003a and b). People have proposed greater investment in the Training of Trainers, better impacts studies (usually through quantitative means), and better (i.e., more) communication as a means to convincing researchers and policy makers in their own language. Nevertheless, despite a wealth of extraordinarily rigorous and specialised economic, environmental, and health studies and substantial investment in communicating results in Ecuador, we found the institutionalisation of FFS to be far less rational process. While FFS scaled in name, the principles often were lost during appropriation. Instead of enabling desired institutional change, scaling exposed vulnerabilities that led to the transformation of FFS.

Rather than preoccupy itself with scaling, the socio-technical change literature would suggest that FFS movements should look at the role of differential growth through increasing "penetration" of the diverse aspects of social life, what in the literature has been referred to as diversification or "broadening scope" of influence (Saccomandi, 1998; Gibbons et al., 2000). The business world learned long ago that the most significant growth was not connected to size but with function (see for example, the research summarized in Gladwell, 2000). For marketing purposes, more important than the length of outreach is the ability to broadly exert multi-purpose influences. As a result, a growing number of businesses and financial institutions have restructured from horizontal (essentially scale) to vertical (scope) integration, and they have sought to broaden linkages through creative forms of communication and interaction. Similarly, Saccomandi (1998) points out that "economies of scope" involve the creative utilisation of a single production factor, which in turn substantially improves returns on both the input and output sides of production. The knowledge production literature has reached a similar conclusion. According to Gibbons et al. (2000: 142), "…. diversification in the functions of [science and research] organisations has increased the number of contacts and promotes the convergence of preoccupations and opened avenues for exchange and cooperation."

Similarly, the work of van der Ploeg et al. (2003) argues that rural development stands to gain through diversification in the hands of users. The initial attraction of FFS to farmers and experts alike was associated with its contribution to improving productivity, especially through decreasing input costs. The studies on the diverse utilisations of FFS in Ecuador found that the methodology could contribute to multiple aspects of rural life beyond on-farm production and productivity, such as increasing the regenerative qualities of agriculture, enhancing solidarity among participants and their families, as well as strengthening the reciprocity of relationships through enhanced circulation of labour, goods, and services (Paredes, 2001; Mendizabel, 2002; Schut, 2006). For example, in 2007 the *Canastas Solidarias* – largely self-financed consumer groups from marginal neighbourhoods of Quito – began to meet with groups of FFS graduates from the north to negotiate new consumer-grower arrangements around "healthy food," a concept preoccupied with not just the end product of commodities but also with the production process itself.[15] Creative new relationships promised to shorten the production-consumption chain in ways that could improve efficiencies through cutting out exploitative intermediaries and improving returns to both producers and consumers. Through strengthening linkages and interactions between growers and producers, such activities also increased accountability at both ends. This appeared to lead to diverse social benefits, such as opportunities for the children of the *Canastas Solidarias* to be able to escape the city and live and work on a farm during breaks in the school year.

[15] The Canastas experience is summarised in Kirwan (2008). The broad concept of "healthy food" was articulated in a national campaign document entitled "Eat well, healthy, and sovereign," Ecuadorian Collective of Agroecology (CEA, *Guardianes de Semilla*, PROBIO, and UTOPIA/*Canastas Solidarias*), July 2007.

Enabling people-centred development

In this chapter, I have drawn on the extremes of Mode 1 (expert-led) and Mode 2 (people-led) knowledge production to describe the multiple epistemological expressions of FFS. Additionally, I have drawn on theories of socio-technical change to assess how institutions appropriated the methodology – e.g., the evolution of FFS as a niche-level innovation to its utilisation by the socio-technical regime. In Figure 6.2, I now draw on the interaction of these two factors to describe competing stages of socio-technical development, useful for describing the evolution of FFS in Carchi from multiple forms of IPM as a novelty to IPM in practice.

Initially, we introduced FFS as a niche-level intervention with the intention of making it an attractive novelty that would contribute to broader institutional change towards people-centred development (from quadrant IV to III). While FFS was successful at becoming a popular novelty, we struggled to conserve its people-centred qualities during processes of diffusion or "massification" of the methodology. At first, we felt this was a question of competency (e.g., as a result of the quality of our Training of Trainers), but after observing previously competent FFS facilitators, such as Joel, lose hold of the methodology, we realized that more subtle social forces were at play. FFS became transformed into an expert-led IPM approach (movement from quadrant IV to I) that quickly "up-scaled" across heterogeneous groups of actors (movement from quadrant I to II) as a result of the structural alignment of Mode 1 knowledge production with the established socio-technical system.

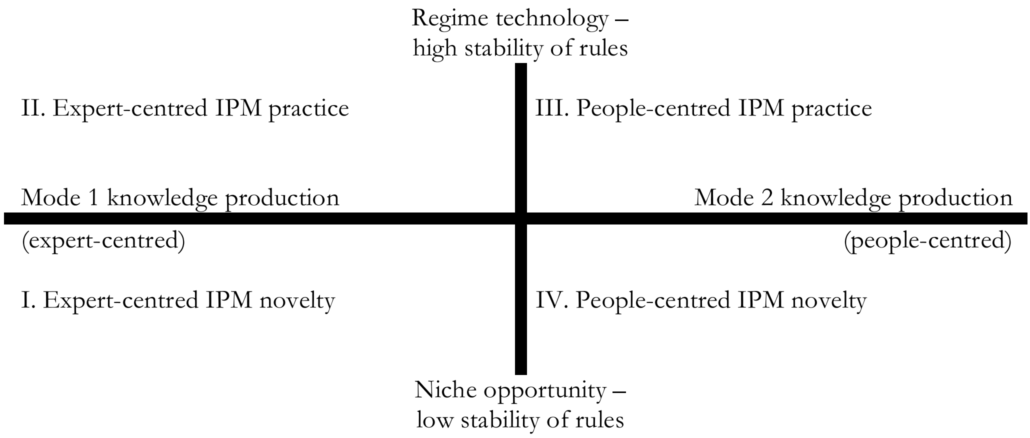

Figure 6.2 Competing stages of socio-technical change

How could regime change towards people-centred IPM have been enabled? Regime level movement between expert- and people-centred development is not expected, since by definition the two regimes are organized around conflicting sets of rules, in this case, consolidated around the extremes between Mode 1 and Mode 2 rationalities. We experienced that the transformation of FFS took place at the novelty level – the "protected space" for exploration and innovation. Change tended to happen at the moment of attempting to scale-up the methodology, when our priorities as project leaders shifted from FFS implementation to diffusion of the methodology, and we released control over the methodology. At that point, the boundaries of influence became more porous, making it vulnerable to competing influences.

Institutional movement towards people-centred IPM practice requires a discontinuity with the established socio-technical regime that generally must come from "below." Since there is little to no alignment with the rules of the regime, change cannot happen through extending reach or scaling up but rather through expanding the depth and breadth of social embrace or scope. Influencing regime transformation requires that FFS broadly penetrate institutional spaces, transforming norms and values and organizing a new power centre around the enforcement of emergent rules.

Conclusions

When I arrived in Ecuador, farmers expressed frustration over the experts, especially those from MAG, INIAP, and private industry. Over time, expert recommendations had created new, more serious problems. Farmers told me that they had done everything asked of them by the *técnicos*, but after three decades, they were worse off than ever.

A common products of modern agriculture – degrading soil and water resources, growing pest problems, dependence on external inputs, unfair prices, and debt – created the pre-conditions for challenging technology-centred development. In this context, we proposed FFS as a novelty for enabling a redirection. While arguably successful at planting a seed of change, our ability to establish a coherent body of knowledge that could sustain such movement into the future was more questionable. Once released in the social wild, FFS took on new and sometimes contradictory forms, especially during processes of going to scale with the methodology. This experience exposed us to previously hidden or underappreciated social phenomena, especially that associated with knowledge production and socio-technical change.

FFS became widely popular with communities, farmer organizations, MAG, INIAP, and the local governments as well as international organizations, such as CIP, FAO, USAID, and COSUDE. FFS quickly rose to the status of "best practice," and as such, it came to be a prestigious symbol. Researchers and *técnicos* tended to accept certain aspects of FFS, such as its ability to "make technologies arrive to farmers." Over time, however, the professionals found certain aspects of FFS more problematic, particularly the aims of placing farmers at centre stage of decision-making and resource utilisation. FFS became vulnerable to contestation.

Through processes of translation, the experts, via their projects, organizations and other control mechanisms, systematically re-shaped FFS. Over time, participants were excluded from determining technical content. "Discovery-based learning" and "learn-by-doing" were replaced with unidirectional lectures. Differences between FFS were lost to pre-determined curricula. The experts reconfigured the proposed outcomes of FFS from human and social development to technology transfer and economic development. The methodology was transformed to the point where participants moved from being sources of innovation to imitators of the experts. FFS underwent processes of objectification and commoditization. It became a simplified and homogenized package that could be distributed and sold through projects. In the process, the methodology was de-localized and de-humanized. In the hands of the experts, FFS shifted from a means of people- to technology-centred development to the point where it no longer seriously threatened established ways of thinking, doing, and ordering.

The performance of FFS in the social wild exposes limitations of methodology-based interventions, and it places into question present calls for scaling-up FFS as overly simplistic. The literature on socio-technical change, strategic niche management, and evolutionary economics suggests that in order to redirect the present trajectory, beyond scale, FFS must influence *scope* – i.e., the penetration of broad social processes that encourage development within the structure of socio-technical change. Namely, FFS must become part of three interactive niche-level growth processes: informing and shaping public perceptions, building an increasingly coherent body of knowledge, and social network building. Due to the radical proposal of FFS, ability to expose the contradictions of modern agriculture and create new expectations is important for legitimising institutional investments in an approach that has limited market value vis-à-vis the existing norms of development practice. In order to respond to such expectations, FFS must enable processes of deep, second-order learning around new norms and values as well as reflection on issues of desirability and feasibility. Growth and institutionalisation of FFS in its original form requires an increasingly influential social network composed of actors from both the competing socio-technical regime as well as emerging sectors capable of creating and enforcing new rules on the production and reproduction of FFS among the heterogeneous set of actors involved in agricultural development.

It is questionable whether FFS would regain original form in Ecuador and when and if ever people-centred development would survive the social wild. Nevertheless, for some, FFS contributed to movement towards conditions increasingly favourable for more localized forms of knowledge production and change. As such, the experience continued to represent a modicum of hope and inspiration. In Chapter 7, I further explore processes of socio-technical change in the context of a power matrix that organized around the perpetuation of harmful technology.

Chapter 7

Dynamics of Perpetuation: The Politics of Keeping Highly Toxic Pesticides on the Market

Summary

This chapter is based on reflective practice associated with efforts to influence pesticide policy in Ecuador during the ten-year period of 1998 to 2007. The chapter explores how institutional dynamics came to form, transform, and influence policy outcomes and how certain actors sought to cooperate, collude and collide to shape public opinion over agriculture technology. Where Chapters 3 and 4 presented a general history of agrarian development in Carchi and Chapters 5 and 6 examined how research and development interventions were only marginally effective at leveraging change, this chapter describes how certain institutional brokers of science and technology manoeuvred to influence and entrench harmful policy. More specifically, I explore how differently positioned social actors built and rebuilt allegiances, gained control over resources, and exercised discretion as a result of controversies provoked by the CIP-led activity in Carchi.

Introduction

Over time, the agriculture concerns in Carchi boiled down to the elimination of World Health Organisation (WHO) Hazard Class Ia and Ib pesticides: the highly toxics. The medical community increasingly agreed that getting rid of this class would solve 90 percent of the acute health problems associated with pesticides (Eddleston et al., 2002), so even though the destruction of water sources, soil erosion, and over-use of agrochemicals remained serious threats to the ecosystem, eliminating the highly toxics became CIP's priority. A pro-health alliance of farmers, social movements, NGOs, and a scattering of individuals in government agencies joined the cause. Further, eliminating the highly toxics had become consistent with the evolving interests of the international pesticide industry, as product development teams had long ago reached the conclusion that more specific, lower toxic pesticides would become the wave of the future. Nevertheless, the national industry continued to financially depend on highly toxics, so considerable resistance remained.

Despite my resolve to wind up this dissertation, in May 2006, Federico,[1] the Provincial Director of the Ministry of Agriculture (MAG) in Carchi, prevailed upon me to attend a joint MAG-CropLife meeting in May 2006.[2] The title of the meeting struck me as a creative mix of terminology: "The Use of Crop Protectors for Improving the Production

[1] In this chapter I have used fictitious names to protect the reputation of individuals.

[2] Joint MAG-CropLife strategy workshop, "The Use of Crop Protectors for Improving the Production and Minimizing the Risks in the Agricultural Zone of Carchi," Ibarra, 24 May 2006.

and Minimizing the Risks in the Agricultural Zone of Carchi." Its stated purpose was to "analyze and define strategies and actions for improving the use of agrochemicals in agricultural production in Carchi."

In addition to being recently named the Provincial Director of MAG in Carchi, Federico was a member of the Humanist Movement, and as such, he was committed to the promotion of "non-violence."[3] While Federico viewed the use of pesticides as problematic, he said that the meeting was agreed upon between CropLife and MAG in Quito, and he found himself in the uncomfortable position of having to implement it. Federico telephoned my partner, Myriam Paredes, also a Humanist, to say, "I want to make sure that the meeting includes your [pro-health] perspective."

By then, my views on highly toxics were widely known. The CropLife probably was not interested in my participation, but since MAG was the co-organizer, it could not prevent the Provincial Director from inviting me. Since former colleagues at CIP – a renown plant pathologist and a soil scientist – happened to be visiting that week, I brought them along as well as a dozen Farmer Field School graduates, who long ago had stopped using highly toxic pesticides.

During a break, I walked over to greet Francisco, the reinstated National Director of CropLife, whom I had not seen in years. Francisco, a lawyer, had left CropLife over a controversy between the national and international pesticide industry. I explained to him that Federico had invited me and that I, in turn, had brought along colleagues from MACRENA, the Humanist Movement, CIP, and the Farmer Field Schools (FFS).

In reference to a controversial publication on FFS that CropLife had co-financed despite never having conducted a Farmer Field School (Barrera et al., 2004), Francisco said, "Have you seen the impact study of our work with INIAP? It demonstrates that we have had an impact. We cannot say statistically that there are less intoxications, but we think so." I responded, "My partners and I will not collaborate with an initiative that continues to permit the use of highly toxic pesticides." Francisco said, "CropLife knows that it needs to promote safer products. The problem is not the international companies." Francisco went on to explain that there were tensions over the right to produce generic products and the US-driven Free Trade Agreement, emphasizing the national industry's misinformation campaign over patents and barriers to formulating inexpensive products for Ecuadorian farmers. He added that recently the controversy had quieted down and the relationship between the national and international industry was back to normal. As a result, he recently had been reinstated as CropLife's Executive Director, and once again, he could speak for both the national and international industries.

During a plenary discussion, a number of farmers, health professionals, and academics gave impassioned speeches on their concerns over pesticides. They did not refer to the past studies nor did they have precise information, but it was clear that there was a

[3] The Humanist Movement espouses non-violence, expressed in physical, economic, cultural, and environmental forms, as per the writings of Mahatma Gandhi and Martin Luther King. For further information, see Mario Rodríguez-Cobos (1996).

growing public perception that pesticides were causing health problems and that the industry and government were responsible. The new Coordinator of the CIP Eco*Salud* project, a medical doctor, and myself emphasized that not all pesticides were "bad" and that we needed to focus on the highly toxics, which were behind the bulk of health problems. We cited a number of published studies to back up our positions. A young pesticide salesman protested in what had become the industry's mantra: "Pesticides are responsible for feeding people in Carchi. There are no alternatives. You cannot be romantic and pretend to eliminate pesticides without offering farmers alternatives."

At that point, the facilitator ended the discussion before we could clarify that we were not proposing the elimination of *all* pesticides or before an FFS graduate could explain that many farmers had been producing profitably for years without highly toxics. Nevertheless, I had come to know that such evidence would not make a difference. The underlying barrier to change was not the highly toxics or a lack of alternatives, but something far more social in nature.

Science as social

> We have no *science* here. You know that Ecuadorians don't like to do research and write it up, so science has not arrived to our farmers. Let me tell you something, I could take you to see 500 farmers, and you'd find that all 500 cultivated in totally different ways. – Patricio, a farmer and former pesticide salesman, San Gabriel

Patricio prided himself as an *ingeniero* or *técnico*.[4] Further, he grew up on a farm, which provided him the insight of "practical experience." He learned at university that science gave universal answers and a "better way of doing things." For Patricio, the problem in Carchi was that farmers needed to be "technified," which involved everyone learning to farm in a single, "right" way: i.e., the way of agricultural science. Such blind faith in science and technology lies at the heart of modern agriculture (see for example, Long and van der Ploeg, 1989).

In contrast, the literature on socio-technology (e.g., Latour, 1987; Woolgar, 1988; Knorr-Cetina, 1999) examines the constructedness of scientific knowledge, challenging notions of science as monolithic and unified, objective, rigorous, and truth seeking. Otherwise, as this chapter will argue, a pesticide would be just a liquid in a container.

According to Actor Network Theory (ANT) scientific knowledge and technology emerge from a process of "heterogeneous engineering," during which social, technical, and conceptual pieces become fitted together or "translated" into products of equal heterogeneity (see for example, Callon, 1986). This involves humans networking not just to interact with other humans, but also to interact with humans and materials. ANT emphasises that technology is not just an artefact, but also a simultaneous mixture of

[4] Refers to the five-year academic degree of *Ingeniero Agrónomo*, the equivalent to a BSc-level degree in the Agronomic Sciences. Rural people in Ecuador often refer to these people as part of a class of educated technicians or *técnicos*.

physical object, human activity, and knowledge (i.e., the know-how to use and sustain technology). Ergo, networks of objects, such as pesticides, participate in the social.

In the same way that science can be seen as a construction, the sides of debates over technology do not automatically exist, nor are they permanent. Rather, they become a matter of negotiation – endless jockeying of interests and coming together over positions and platforms. Techno-science networks emerge during the construction of interests and identities as a result of processes of alliance building, translation, and representation.[5] If pesticides disappeared, then so would a particular social order.

While Latour (1987) and Knorr-Cetina (1999) concentrate on the early stages of "science in process," in this chapter I examine a ready-made product of science: synthetic pesticides. At this later stage of socio-technical change, actor networks have matured largely as a result of the effective popularization of earlier proposals into dynamic collectives of allies having well-defined, though always malleable boundaries. These boundaries may consist of formalized administrative means with highly articulated positions, hierarchies, administrative mechanisms, and rules, as well as growing resistance from alternative interests. Later in their social life, networks become made up of identifiable organizations and faces that operate in elaborate governing structures – "socio-technical regimes" – that deliberately attempt to exert influence over the broader techno-science community.

Context and methodology

This investigation took place in the social arena where knowledge encounters and negotiations over agricultural technology take place and in the common spaces where interests converge and contribute to concerted action among actors. As an active participant in the examined activity, I largely base the research on reflective practice. I aspired to capture how different groups of actors (farmers, agronomists, health professionals, researchers, private industry, and government officials) both intellectually and organizationally built alliances, positioned and repositioned around pesticide technology, as well as how they reached consensus on explanations, coped, and strategised. My analysis concentrates on networks of social actors, while Paredes (in process) considers more nuanced individual and localized phenomena.

This chapter draws on a series of critical events that took place between 1998 and 2007, as recorded through project documents, published theses and other studies, and media coverage, as well as my personal notes and correspondence as a direct participant. I write in the first person so that the reader can clearly identify my involvement. Further, the team of researchers on which I drew for the historical work in Chapter 4 conducted open-ended interviews with key informants that were recorded and transcribed. I also draw on the recordings of the BBC's interviews during the production of its two-part series on the

[5] Latour (1987:29 and 174) forged the term 'technoscience' to conveniently summarize 'science and technology'. In practice, he used technoscience to, "describe all the elements tied to the scientific contents no matter how dirty, unexpected or foreign they seem." Latour used 'science and technology' to designate what was kept of technoscience once the "trials of responsibility" were resolved and assigned.

effects of globalisation in Carchi, "Dying to Make a Living."[6] I make regular use of footnotes and citations to reveal sources. Further analysis explores patterned behaviour, interactions between and among actors, and subsequent actions and reactions.

I continue with descriptions of two concurrent and interacting key events: public discussions and forums on the pesticide research and the industry's responses and efforts to win support for its positions, before shifting attention to the actions and reactions generated by this activity. In the discussion section, I examine the social face of pesticide policy in action, specifically underlying modes of enactment and change, in order to shed light on the constructedness of agriculture technology in Carchi.

Critical events

As summarised in Chapter 2, initially my colleagues and I assumed that influencing agricultural policy was simply a function of providing better quality information. Alerted to the pesticide concerns in the early 1990s, CIP and INIAP produced extensive multidisciplinary research aimed at understanding underlying problems and devising cost-effective alternatives. Medical studies found that a majority of rural people suffered neurological damage. Diverse research on the social and economic factors behind pesticide exposure found industry and government Safe Use of Pesticide (SUP) campaigns ineffective. Over time, we came to agree with others (for example, Atkins and Leisinger, 2000) that it was not realistic to expect farmers who lived under the socioeconomic conditions of rural Ecuador to use pesticides safely, with or without SUP training. Drawing on the recommendations of industrial hygiene, the team of CIP and INIAP researchers concluded (Yanggen et al., 2003b: 197):

> In summary, our studies, in agreement with the published conclusion of the pesticide industry, find that the socioeconomic conditions of rural communities in places such as Carchi do not permit the safe use of extremely and highly toxic pesticides. As a result of this situation, it is very worrisome that the country permits the free sale of these products when it is evident that they will not be used safely and that this will cause neurological damage that directly affects productivity and the well-being of rural communities.

Meanwhile, we organized around the proposals of Integrated Pest Management (IPM), which in Carchi emphasized farm productivity improvement through reduced use of agrochemicals – both synthetic pesticides and fertilizers. As described in Chapter 6, we promoted IPM practice through the knowledge-based designs of Farmer Field Schools. In summary, pesticide-use reduction through IPM became our proposed technology trajectory and FFS its carrier. The elimination of the highly toxics became our political rallying point and battle cry.

Colleagues produced scientifically rigorous studies under the conceptual framework of Tradeoff Assessment on interactive health, environment, and productive factors

[6] Lynne Mennie and Euan McIlwraith of the BBC World Service conducted these interviews during 7-14 September 2003.

(Crissman et al., 1994). They identified a number of positive sum policy alternatives centring on practices that could potentially decrease exposure and improve production, thereby positively contributing to both health and economic objectives. We quickly learned, however, that the barriers to change were not so straightforward. After five years of attempting to leverage policy change, a somewhat frustrated team of researchers concluded (Yanggen et al., 2003a: 2):

> The health problems caused by pesticides are severe and are affecting a high percentage of the rural population of the Carchi Province in Ecuador. Technology and policy solutions exist that can substantially improve the health of the province's population and are economically viable. Despite the gravity of the problem, little progress has been made at the aggregate level. Government policies have long promoted the use of [highly toxic] pesticides. A clear political will has not existed to date to reverse this situation."

We discovered a complex and dynamic cultural power matrix surrounding pesticide use that was far more organized and capable of shaping public opinion and policy than we were. This chapter goes on to highlight three interactive processes that took place over the eight-year period of 1999 to 2006: a series of public forums on research outcomes, ensuing media activity, and the provoked responses, especially from the pro-pesticide alliance.[7]

<u>Against the flow: questioning pesticide technology</u>

> I apply pesticides to my potatoes so that I can go to sleep at night. – a farmer from Santa Martha de Cuba

In Ecuador, *Carchenses* are known as hard-working people with richly diverse views who generate lively conversation on everything from politics to the potato. Nevertheless, when we arrived essentially everyone agreed on one matter: pesticides were a blessing.

The weather, continual pest and disease outbreaks, and market variability made farming a high-risk enterprise and farmers a class of gamblers. In this context, a technology that was perceived to decrease vulnerabilities was highly valued. Over time, many farmers literally came to view pesticide technology as a godsend (Mera-Orcés, 2000 and Paredes, 2001).

Pesticides helped farmers rest a bit more easily at night. They gave extensionists easy answers to farmers' questions, which in turn provided value to their years of study and employment as *técnicos*. If farmers were happy, politicians were happy. Farmer enthusiasm

[7] I use 'pro-pesticide alliance' to refer to the dynamic collection of individuals and organizations that collaborated and strategised to sustain present farming practice. For financial and employment purposes, the well-being of these actors depended on the use of pesticide technologies and other external inputs. Over time, this situation led to the promotion of over-applications and the extensive use of highly toxic products. A competing group emerged around the theme of health and lobbied for decreases in pesticide use and the elimination of the class of highly toxics and other problematic pesticides, such as the fungicide mancozeb that was of lesser toxicity but a suspected cancer-causing agent. I refer to this group alternately as the pro-health alliance or lobby.

over pesticides led them regularly to let go of their hard-earned cash, which concentrated in the hands of a now well-established class of salespeople and vendors, many of who had become rich, very rich. Seemingly, everyone won with pesticides.

The farming sector continued to expand into the 1980s generating exponential sales of agrochemicals, which financed new vehicles and houses for industry folk in San Gabriel, Guayaquil, Philadelphia, and Bonn. Pesticides had come to allow people to get on with daily life. The land in Carchi was robust; the rainfall was evenly distributed throughout the year; the sun rose in the morning, and agrochemical technology was plentiful. Things were good, that is, until we came to town.

When I arrived in 1998, the Head of CIP in Ecuador, Charlie Crissman, and the Occupational Health Specialist, Donald Cole from the McMaster Institute of Health and the Environment in Canada, told me that it was our duty to "inform the public" on the research findings. I was hired to produce informational bulletins and to organize public forums in communities as well as at provincial and national levels as a means of "sharing the results." Since pesticides were not perceived as a problem in Carchi but rather a solution, my first task was to shake-up things.

I began by working with the Eco*Salud* team on a series of radio announcements and educational programs for broadcast throughout the province on the startling health effects of pesticides. We documented dramatic testimony on intoxications and produced bulletins emphasizing that pesticides affected two-thirds of the rural population at levels that would justify legal recourse in many countries. We also demonstrated the viability of alternatives through modelling and Farmer Field Schools. Staff sought linkages with a broad group of local organizations with which we felt there was, or could be, complementary interests, such as municipalities, NGOs, and universities. The project nurse participated in provincial Health Council meetings and the project educator joined a local development consortium. As I worked to mobilise a grassroots response around the Farmer Field Schools, I also became increasingly active in lobbying efforts at multiple levels. Eventually, this activity would place me in the path of the influential pro-pesticide alliance.

In October 1999, we organised a province-wide stakeholders meeting entitled, "The Impacts of Pesticides on Health, Production and the Environment." While preliminary at the time, the data already made clear a serious health and economic situation in Carchi associated with widescale overuse of agrochemicals, especially highly toxic pesticides. Over 120 representatives from government, private industry, development organizations, communities, and the media participated in the daylong event.

Following a series of presentations from the CIP-led team of investigators, the legal representatives from the provincial councils of agriculture and health chaired breakout sessions. Ministerial representatives from agriculture, health and education participated as well as the governor of Carchi and mayors from each of its 14 municipalities. One notable outcome of the meeting was the formation of an ad-hoc committee composed of directors from INIAP, the Ministry of Education, and the Ministry of Public Health charged with producing a list of recommendations, which would become "The

Declaration for Life, Environment and Production in Carchi" (Box 7.1). The Carchi Declaration called for "the eventual elimination of highly toxic pesticides" as well as a number of measures designed to heighten awareness over the hazards of pesticides.

Box 7.1 "The Carchi Declaration for Life, Environment, and Production"

As a result of the October 1999 stakeholder meeting on "The Impact of Pesticides on Health, Production, and the Environment," Directors from INIAP, the Ministry of Education, and the Ministry of Health drafted the Declaration for Life, Environment and Production in Carchi," calling for:

- assurance of greater control on the part of the Ecuadorian Agricultural Health Service (SESA) of the formulation, sale and use of agrochemicals, including the prohibition of highly toxic products (WHO Hazard Classes Ia and Ib)
- introduction of information concerning the impact of pesticides on health, the environment and farming productivity into the basic school curriculum
- inclusion of IPM as part of the degree requirements for university level agricultural technical training
- commitment of further resources to research and training in integrated crop management with an orientation towards the reduction of pesticide use and safe use of pesticides
- promotion of awareness-raising in rural communities on the side effects of agricultural practices and the use of more environmental and health friendly practices
- the agrochemical industry's direct financial support in the completion of these resolutions

The provincial forum ended with participating authorities asking CIP – specifically me – to take the Declaration to the National Pesticide Committee (NPC), the Congressionally appointed advisory committee composed of representatives from the Ministry of Agriculture, Public Health, and the Environment, the Ecuadorian Plant and Animal Health Service (known by its Spanish abbreviation, SESA), and the Association of the Industry Animal and Crop Protection Products (known by its Spanish abbreviation APSCA; today CropLife-Ecuador).[8] The NPC was charged with the responsibility of overseeing national pesticide policies. The industry's subsequent activity would assure that the Carchi Declaration would never seriously enter into public debate.

[8] APSCA grew out of the Association of Importers and Manufacturers of Agriculture Inputs and Similar Lines (known by its Spanish abbreviation, AIFA) (CropLife-Ecuador, nd:2). Created in 1978, AIFA advocated in favour of Ecuadorian Law 73, which in 1990 established the norms and standards for the formulation, manufacture, importation, sale and use of pesticides and similar products. Also, it directly participated in the creation of the 1994 Law of Agrarian Development that ended the government's policy of land reform that began in 1966. Later, AIFA lobbied to create unified regulatory standards for pesticide in Ecuador and the Andes. In 1999, AIFA became a member of the regional Latin American Crop Protection Association (LACPA) and changed its name to APSCA. As part of an effort to modernize its image, in 2001 LACPA became CropLife-Latin America and APSCA became CropLife-Ecuador.

Industry response

In 2001, I participated in a series of meetings with the National Pesticide Committee over the CIP-led research in Carchi as well as the Carchi Declaration. During one meeting, Maria, a toxicologist and the representative of SESA as well as acting President of the Committee, argued that based on the recent findings, the Committee had the responsibility of recommending a review of the policies governing the sale and distribution of highly toxic pesticides. This motion caught the attention of the Executive Director of APSCA, Francisco, who was quick to argue, "The elimination of pesticides would jeopardize farm productivity and food security." I emphasized that the recommendations did not speak to *all* pesticides but just *WHO Class I* products. Placing a dozen publications on the table, including industry-led studies, I explained once more that the highly toxics were responsible for the bulk of health problems associated with pesticide use in developing countries. While that day I may have made a convincing argument before Francisco and the rest of the NPC, the battle over pesticide policy reform in Ecuador was far from over.

The NPC agreed to co-sponsor with CIP and INIAP a national forum on the Carchi research, which took place in Quito in May of 2001. Several weeks prior to the national forum, Francisco invited me to give an exclusive seminar for the members of APSCA. Having a number of former students and friends in the agrochemical industry in Ecuador, I thought there was a chance that APSCA would consider eliminating the highly toxics. The closed-door meeting took place on the top floor of the Ministry of Agriculture building and involved 43 salespeople and mid- to upper-level managers from agrochemical companies operating in Ecuador.

Entering the seminar, I did not fully appreciate the disquiet stirred by our research. I gave a one-hour presentation summarizing the health and economic findings, the potential of FFS in IPM as an alternative, and the rationale behind CIP's policy recommendations. The subsequent discussion carried on for over two hours. Many people brought with them a bound copy of the preliminary studies from the earlier forum in Carchi. Referring to underlined texts, I was asked to provide detailed explanations of different experimental designs and analyses.

Days later, the President of APSCA sent me a letter in which he carefully interpreted the findings of the CIP-led studies:[9]

> A brief analysis of the studies realized by you [CIP and INIAP] clearly show that the production of potato in the Andes requires pesticides and resistant varieties, and, in the case of Carchi, their use is economical and efficient. The studies also show that the use of these products has not caused environmental contamination, nor have they found residuals on potatoes, prior to peeling and cooking, beyond permitted limits. These findings, of fundamental importance, indicate that pesticides are not [adversely] affecting production, the environment or consumers.

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[9] Letter received from the President of APSCA, 28 May 2001.

The letter produced different reactions within the CIP-led team of researchers. The lead Ecuadorian economist argued, "Our job is to produce the information. As scientists, we should not get involved in politics." At the time, Crissman and the others researchers on our team nodded in agreement. In contrast, I argued that as a rural development practitioner, I felt we had an obligation to not just produce information but to proactively influence public opinion. Eventually, I would come to appreciate that, as a foreigner, my future was less threatened than that of my national colleagues by confronting influential people in the country. I also would learn that Ecuador's educational system and its professional organizations, in particular the *Colegio de Ingenieros*, created linkages that intellectually and socially tied staff to our political opponent: the agrochemical industry.

The day before the Quito national forum a half dozen industry representatives from the United States, Central America, Colombia and the city of Guayaquil, where most Ecuadorian chemical companies were based, made a surprise visit to the Santa Catalina Research Station to meet with the CIP researchers. This time, instead of requesting more information on the studies, the industry officials informed us of their collective position. The representative of CropLife-Latin America began by saying, "We cannot be held responsible for farmers' careless handling of our products," and he expressed concern over our call for eliminating highly toxic pesticides. In lieu of "unnecessarily radical measures," another representative suggested that we work together for "more feasible changes than the removal of products from the market." After about 30 minutes of listening to what sounded like a well-rehearsed script, Crissman abruptly stood up and asked them to leave the station. Afterward, Crissman told the CIP team, "I'm now convinced that Ecuador needs to eliminate the highly toxics."

The next day, the Minister of Agriculture and the FAO Country Representative opened the daylong national forum for an audience of about 150 people. Although I had met privately with each to go over the agenda and provide printed material on the studies, both the Minister and FAO Representative strategically avoided the theme of pesticides in their respective speeches. Instead, each made vague statements about the importance of food security and the role of modern technologies in feeding the rural poor of Ecuador.

Following the introduction, the CIP-led team gave a series of presentations on the results of different health, environmental, and economic studies. Afterward, representatives from the Farmer Field Schools in Carchi demonstrated their tested alternatives for substantially reducing reliance on the highly toxic insecticides carbofuran and methamidophos as well as the suspected carcinogenic fungicide mancozeb. Through alternatives such as the Analysis of the Agro-Ecosystem and pest traps, the farmers argued, not only were they able to avoid health risks associated with pesticide use, but also they substantially decreased input costs. The farmers concluded with a call for attention to the Carchi declaration and requesting support for the burgeoning FFS movement.

During the day's question and answer sessions industry officials repeatedly expressed concern over the proposal of eliminating Class I insecticides. Surprisingly, the Director of SESA (and President of the NPC) did not show up for the forum. A replacement sat in, but she lacked the authority to propose the Carchi Declaration. Later, I learned that the same group of industry representatives that had visited CIP had also visited the SESA Director the night prior to the national forum. Between that time and the morning, the Director had decided not to participate in the forum. Despite dozens of subsequent letters from farmer groups and development and research organizations requesting attention to the Carchi Declaration, SESA never responded, and as a result the NPC never publicly sanctioned the Declaration of Carchi and the provision for eliminating the highly toxics.

At the very least, the Quito forum caught the attention of the media. Following the airing of an investigative television program on pesticide poisonings in Carchi,[10] I received a number of telephone calls from national and international industry representatives who expressed concern over what one caller described as the “exaggerated presentation of the facts.” Citing the CIP studies, the APSCA representative told me, “The country’s food security depends on pesticides and the ability of farmers to manage products safely.” The callers generally emphasized the same solution: a collaborative Safe Use of Pesticides training program involving CIP, INIAP, the Ministry of Agriculture, and municipalities.

The following year, INIAP, CIP and the FAO publicly launched a Spanish language book (Yanggen et al., 2003a) summarizing the overall research to a group of over 100 public officials, industry representatives and media. In-depth radio programs and newspaper articles followed. SESA officials and pesticide industry representatives responded with now familiar behaviour: seeming concern over the alarming health effects of pesticides, but disdain for calls for the market removal of the highly toxic insecticides. As per the findings of the aforementioned BBC World Service radio program, the industry’s position had become the official government position: "We have established international standards of recommendation and have forced the pesticide industry to obey those rules" and "We cannot be held responsible for farmers' misuse of pesticides."[11]

Despite over a decade of research and overwhelming evidence on the hazards of pesticide use in Carchi and substantial public demonstration of rigorously studied cost-effective alternatives, it became clear that policy did not primarily depend on high quality information. In the end, we reached the same frustrating conclusion as Wesseling et al. (2005) in Central America (p.S697): “Documentation of pesticide poisonings during several decades never induced any decisions to ban or restrict a pesticide.”

Truth and consequences

We found that in practice policy outcomes on pesticides were not shaped primarily by thoughtful analysis of information, but rather strategic framing and reframing of issues expressed through the assertions and activity of influential actors and their networks.

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[10] *Amargo cosecha* (Bitter harvest), a documentary produced by Adolfo Asar of the *Día a Día* Program, first aired in September 2001.

[11] For a link to the two-part World Service program, see BBC (2004).

Claims

> Carbofuran is the number one selling insecticide in the world for years, and we are proud that it was one of the tools in the green revolution that helped feed the world's people. – Director of Global Regulatory Affairs, FMC Agricultural Products

Jansen (2000: 14) identified three central arguments on which the industry draws to claim that Safe Use of Pesticides is the right response to pesticide-generated health concerns: 1) pesticides are indispensable for feeding growing populations and enabling farmers to escape poverty; 2) experts extensively test and approve pesticides for the public; 3) the industry has developed effective safe use programs. The pro-pesticide alliance in Ecuador essentially made the same arguments, with the addition that farmers (i.e., users) and not industry (creators and producers) were responsible for poisonings.

Indispensability of pesticides

> Ever since the research and the *Día a Día* documentary, no one has wanted to buy potatoes from farmers in Carchi. As a result, prices have dropped and farmers are going broke. – a pesticide salesman in San Gabriel

Following the presentations by the Head of CIP-Ecuador and me to a large group of farmers at a provincial potato fair in Carchi,[12] a pesticide salesman stood up and criticized the investigations. He contended that our research was responsible for the bad year that potato farmers were facing. (Fortunately for us, most of the several hundred farmers in the room understood that other factors were behind the situation, specifically low prices followed by a late blight disease outbreak.) Claims followed that all pesticides, including the highly toxics, were indispensable for farming and the economic well-being of farmers.

This reminded me of a letter than I had received years earlier from the President of APSCA, who argued, "In Ecuador, late blight will destroy nearly 100 percent of the potato crop if fungicides are not used. The Andean weevil can attach up to 80 percent of tubers of a plot if insecticides are not applied. Potato is the only crop that can provide sufficient food for the Andean population in these regions of high elevation with little available land and short growth cycles."[13] He asserted that a reduction in pesticide use would bring financial harm to farmers: "...the solution of certain groups to completely abandon pesticide use or speak of the elimination of highly toxic compounds would be difficult to convert into a practical solution for the population and wild fauna, since it implies a drastic reduction in harvests."

In its brochure justifying the continued distribution and sale of Class I pesticides, CropLife-International makes similar assertions (CropLife, nd: 3): "Pesticides are essential to farming economies, especially in developing countries and economies in transition, where adverse effects caused by weeds, diseases and pests are greater. They are critical in

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[12] Potato Fair, El Angel, Carchi, 12 September 2003.
[13] Letter received from the President of APSCA, 28 May 2001

order to meet the food and fibre needs of the global community." By drawing the line at all pesticides, the industry argues that the harm of eliminating a particular category of pesticides is tantamount to eliminating all pesticides, which in turn would lead to "poverty" and "hunger."

In December 2003, PAN-Ecuador interrupted a joint FMC-INIAP conference on the "correct stewardship of carbofuran," which involved experts from FMC's public relations and pesticide safety units in Brazil and the United States as well as over 30 high-level representatives from companies and research institutions – the regional copula of the pro-pesticide alliance. The response, as managed by Jonathan, the Director of Global Regulatory Affairs at FMC Agricultural Products, is instructive on how the industry organizes to counter challenges to its position that the highly toxics should remain on the market.

Jonathan was addressing the congress when a group of about 15 protesters barged into the auditorium, shouting and handing out pamphlets. He waved down the disapproval of the audience and stopped the hotel security that had arrived to escort out the protestors. Jonathan asked the protestors to stay for a few minutes:

> Part of our reason for being here [in Ecuador] is to listen and to gather information from every segment of the population. So, we are very interested in anything you have to say about pesticides, and specifically FMC pesticides. If you have real information about intoxications, please convey that to us. Let us see that because we know that these things can happen. Though death, that is, unintentional death, is rare for carbofuran, we know that these things do happen. We are very concerned about them. We see this as our purpose, to see that we get the benefit of insecticides use for farmers and try to avoid the risks, because the real purpose of insecticides and pesticides, in the end, is to help feed the starving people of the world. And this is well recognized by the FAO, in announcements by the Assistant Director General, that pesticides are important, because we have many people to feed, and they are just one tool in this toolbox to accomplish that goal. But we don't want people to be exposed to unnecessary risks. We just want them to get the benefits. So, please send us the information.

The pro-pesticide alliance continually sought the "goods" of pesticides as evidence of the value of *all* pesticides. Meanwhile, it downplayed or completely obviated their "bads." Rather than acknowledge the harmful neurological effects of carbofuran, Jonathan said that "unintentional death" due to carbofuran was rare.[14] By suggesting action based on "unreal" information, he alleged that the "seeming good intentions" of the protestors was actually "anti-farmer" and "against the poor." In so doing, he positioned the industry on the side of farmers in its ardent defence of the indispensability of pesticides, including the highly toxics.

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[14] In fact, recent research has found that access to acutely toxic pesticides in rural communities indeed is associated with high suicide rates (Bertolote et al., 2006)

Trust the experts

> Furadan... is registered in more than 80 countries for over 30 years.... Today it is one of the most studied products. We have over 20,500 bibliographic citations. If you go to the university, in universities you will commonly find over 1,500. It is important to note that [Furadan] is a highly studied product. – FMC Regional Safe Use of Pesticides expert

After the protestors' were gone, the representatives from the national pesticide industry apologised to Jonathan for the "indignation." They called the interruption "rude" and a "violation," describing it as typical of the socially unacceptable behaviour of "…the radicals we have to deal with in Ecuador." One man stood up and said that rather than resort to such "violence," the protestors should solicit "public space for dialogue, where they could present their studies and practical alternatives for helping the poor."

Such arguments aimed to shift the burden of guilt from the industry, which was "unfairly accused" of poisoning and killing thousands to that of the protestors, who "wilfully" violated social norms and disregarded the interests of the poor. Holding the position of proprietor of not just the rented space but also of truth and justice, the pro-pesticide alliance sought, and often was awarded, the final word.

In reference to the concerns raised by the protesters, I asked Jonathan:

> Your coming here indicates that you may have heard about some of the research in Carchi, in Northern Ecuador. We've done a lot of studies in Carchi with a number of international organizations. Many of these confirm what you say in the US – carbofuran not causing serious environmental damage. Certainly we do not find quantities of carbofuran [in Carchi] that are above the EPA standards, in terms of metabolites in ground water, surface water, even on potato, even before cleaning and peeling. We were looking. What we have become concerned about are the exposure conditions, which are substantially different than in the US. We are finding a large percentage of the rural populations neurologically affected, and we believe that this is due to exposure to insecticides. We cannot specifically tell you if this is due to carbofuran, methamidophos or a combination of the two, but it is suspected that the acute results are due to carbofuran. We are talking about 60 percent of the population being measurably affected. We find metabolites of carbofuran on clothing, in the home, in dust in bedrooms, the kitchen, that is, throughout the house. People are continually exposed to carbofuran, which makes them chronically ill.

Jonathan responded:

> We are always listening. And when there is valid information that we are not aware of, then we make an effort to act on it responsibly. The part about connecting neurological effects is a very difficult connection to make. What we have is correlations. Correlations can be very dangerous and very misleading.

> Take this as a general comment – it's not about carbofuran. The most humorous example of the problems with correlations that I can think of is this: we know that the birth rate is going down in Sweden. And we also notice that the stork population is going down. And, then we conclude therefore that storks deliver babies. Having said that, there are so many different ways to study neurology. We need to be objective. It's o.k. to have working hypotheses, for example, that the neurological effects are due to pesticide use. Then, as a scientist, I would say, was Ecuador a consumer of DDT before carbofuran was even registered? I imagine it was. Do we know what the levels of DDT are? Because we know that there are still high levels of DDT around throughout the world, including the US. Now we say, which one is it due to? Is it a residual effect of DDT? The only thing we can do, in the absence of being able to make that connection, is to try our best to work to eliminate exposure. And when we find exposure in the household, trying to relate that to the native things. From a scientific standpoint, that is all you can do. We cannot avoid the working hypothesis that other people come up with, but we can put it to a scientific test. If that information is published, then I would be interested in getting the reference to it. We are interested.

I responded in support of the research:

> As you say, explaining cause and effect is tough, but we do have control populations, strong statistical designs, and a high degree of confidence in the research results. These are studies that have been published in distinguished academic journals – health and economic journals – in the United States, Canada, and Europe. The difference between controls and the at-risk populations was large. We are talking about one standard deviation off the norm – that's an order of magnitude – between the neurological performance of the control and test populations. When we explored the different variables, we found that the results were best explained by exposure to the insecticides, 90 percent of which were two products: methamidophos and carbofuran.

Before moving on to another person, Jonathan provided one last comment:

> Science is about being open to error and reconfirming results and having the scientific community comment on them. That is the tradition of science. So I hope you can send me those references so that I can follow up on those. What you say may be an important contribution to what we know about carbofuran, and I want to thank you for that.

Jonathan's reactions to the protestors and me that day represented common behaviour of the agrochemical industry. He challenged the validity of the information and then, when confronted by claims of legitimacy, he passed on the onus of proof to the public (or its government) in providing further information, while placing the industry – the judge and authority – in the position of making the final decision. Jonathan expressed sympathy with the protestors (and me) and then invited them to "stay in contact" and "keep him informed," ostensibly so that "He," signifying the experts and the industry, could continue to assign "truth" to our experience and determine appropriate future courses of action. This patterned response demonstrated an institutional disregard for the precautionary principle – the safeguard doctrine that the introduction of a new product or process whose ultimate effects are disputed or unknown should be resisted. Ultimately, the industry argued: trust the experts, and in the meanwhile, the highly toxic pesticides should be deemed innocent until proven guilty.

The industry's solution: Safe Use of Pesticides

> With backpack sprayers and fumigators in poor condition, without any protection or consideration for the harm to their health or the environment caused by non-adequate application methods, the farmers go out every morning to their jobs, without worry about the problems they cause. – CropLife-Ecuador (nd: 5)

The industry selectively interpreted the INIAP studies, thereby justifying present rates of pesticide use: "According to the research of INIAP, the reduction of pesticides will not increase crop harvests [of potato in Carchi]; nevertheless, it has been proven that a better use of pesticides could help producers reduce production costs by 25 percent, which provided total production costs of between 1,800 and 2,200 dollars [per hectare] represents significant savings." (CropLife-Ecuador, nd: 5). This paved the way for APSCA's alternative: "... as the same [CIP and INIAP] study indicates, the farmers recognize the dangers associated with the use of these products, but the local attitude is that pesticides can be tolerated by the strongest people. This fact clearly demonstrates that what exists is a lack of awareness in the safe use and management of these products."[15] The pro-pesticide alliance framed the blame of intoxications and deaths on pesticide users: farmers.

The industry's proscribed way forward became:

> ...an aggressive educational and training campaign on safe use and management of phytosanitary products and IPM. For this, the industry has a program that it has been implementing throughout Latin America. In our country, we initiated a pilot in 1999 with rice producers in the lower watershed of Guayas, which led to excellent results, having trained in the first year 2,400 farmers.

The pro-pesticide alliance never confronted the health effects head-on; rather it redefined the problem as farmers' "misuse" of pesticides, which eventually became transformed to a lack of "safe use." This primarily meant the promotion of Personal Protective Equipment (PPE). Since our studies showed that non-users, principally women and children, were nearly as affected as those who applied pesticides, we knew that PPE would not work (that is, unless women and children wore PPE 24 hours a day). Such evidence, however, had little effect on belief creation and policy.

CropLife proposed employing the industry-wide Scarecrow program in Carchi that centred on SUP and targeting grade schools as a means to reaching parents (Box 7.2). Of

[15] Letter received from the President of APSCA, 28 May 2001

the dozens of companies that attended our information sessions, two responded with SUP initiatives of their own to the growing public concern over pesticides in Carchi: FMC and Bayer. Not coincidently, these two companies were responsible for inventing the two products responsible for the bulk of health problems in the province: carbofuran and methamidophos, respectively. FMC's educational campaign focused on "rational and adequate use of carbofuran." Similar to the Scarecrow programme, its approach aimed to reach adults through grade school children. Meanwhile, Bayer focused on adults through "AgroVida," a longstanding program that was developed in Central America. All three programs included standard safe-use courses as well as substantial investments in public relations material, such as pencils and notebooks for children and baseball caps for adults.

Box 7.2 The Scarecrow program for grade school education on Safe Use of Pesticides (CropLife-Ecuador, nd: 4)

In 2001 the industry initiated the "Scarecrow comes out in defence of nature" program in the rice-growing region of Guayas province, as part of its "Plan America." That year, it presented the program to 1,148 schoolchildren between the ages of 10 and 15 from 28 rural schools, declaring, "Rural grade school education is central to the future of agriculture." The stated goal of the campaign was:

> to change the mentality of adults through their children and to form tomorrow's farmers with information on the Correct Use of Products for Crop Protection and Integrated Pest Management, in such a way that children were trained to recognize the most important local pests and insects, diseases and weeds in the area as well as the risks associated with the poor uses and abuse of products.

The training program used a pre-developed slide show and a graphic manual. It included drawing contests and written tests where awards were given to the best performers.

As a result of the perceived success of the project, CropLife launched a second Scarecrow campaign, which included changes so that "children can retain concepts more efficiently" and reach an additional 2,000 children from rural communities in Ecuador. Subsequently, CropLife and FMC applied Scarecrow's central strategy of targeting grade school children for its safe use of pesticide programs in Carchi.

In late 2001, an official from Bayer Cropscience invited me to participate in the inauguration of its SUP program, AgroVida, which included officials from MAG, SESA, INIAP, FAO, and the German government and took place in a luxurious five star hotel in Quito. In his presentation, a regional training specialist showed data demonstrating that Bayer had trained tens of thousands of farmers in SUP, leading to measurable impact in about 20 percent of participants. As a result of this experience, he had discovered that the problem of "pesticide abuse is the creation of farmers" and the true underlying issue was one of "public perception." He concluded, "The risks associated with pesticides are manageable." When challenged over reaching only a small percentage of all farmers, similar to the quotation of Christian Verschueren, the Global Director of Crop Life International, that opened this dissertation (page 1), he admitted that his work was only a "grain of sand on the beach" if one considered the millions of farmers in Latin America, not to mention the billions in the world. Nevertheless, he pointed out, "AgroVida is a clear demonstration of Bayer's commitment to small farmers." In the end, SUP was less about actually protecting farmers from the toxins of pesticides and more about demonstrating to the public an interest in protecting farmers.

Contradictions

> If you have the knowledge and the power to regulate the industry, it will respect your authority. And, I have made the industry respect my authority. – M. Bolaños, former Director of SESA and consultant to the FAO's SUP program in Ecuador (*Dying to Make a Living*)

The pro-pesticide alliance's concern for public well-being fell into doubt as a result of three deeds: 1) aggressive sales tactics, 2) refusal to promote pesticide-use reduction, especially of the highly toxics, and 3) cooption of public agencies.

Aggressive sales

Over time, the pesticide companies have adopted increasingly aggressive sales tactics. One salesman explained that in the early days sales depended on having a useful product and being a good friend to farmers:

> To sell you need to be a friend, to be able to talk and tell a joke. I could entertain, just like I am entertaining you here tonight. The people would never leave when I started to talk. Once I got sick, I was in a car accident, and was in the hospital and all the farmers came to visit me in the hospital and buy products off of me. I sold 149,000 Sucres; it was my best sales year ever.

By the late 1980s, however, competition grew and the number of *técnicos* needing to sell their products increased. In some instances, vendors were forced to promote older products of questionable value. As a result, being friendly was no longer enough, and vendors resorted to more aggressive means of reaching their targets. A salesperson in San Gabriel explained:

> They told us we had to push "bad" products; I had to meet my quotas even when we knew that what we were selling was no longer of any use. As a result of this situation [of over-application], we caused the pests – both insects and diseases – to develop resistance. For this reason, no conventional product is going to lead to results. The companies know how to take advantage of this situation... So, how was I going to sell useless products? I'll tell you how...We started buying pigs to roast and gave out hats and t-shirts, and gave away backpack sprayers. I've done everything to sell my products. I even bought *aguadiente* out of my own pocket, because I could not turn in receipts for alcohol. If the farmers have a good time, they buy my products. I've organized more *fiestas* than all of Carchi put together, and won a prize as the best salesman in the area.

A vendor privately admitted to me that the companies promoted over-use of highly toxic pesticides through high application rates: "In the US it [carbofuran labels] says the application rate is 500 ml/ha [for potato]. Go look for a bottle. What happens in Ecuador? In Ecuador, we use four to six litres per hectare. Go make your own comparison. Imagine what that much red label product can do in a hectare." Additionally, international companies used their brand name to sell highly toxic pesticides at inflated prices:

> How was Bayer? It paid better. The products were the same. Bayer had to sell its products expensively as a matter of principle. I had to sell Curater, a red label product, and since it was Bayer I had to sell it expensively. At Farmagro, first we sold products cheaply; secondly, I was told not to give too much emphasis to red label products. In Bayer, there was a lot of pressure to sell Curater and Bulldog. And the competition was very difficult. Bayer could never sell a product at a cost cheaper than the competition. It went well for the company, but it was extremely difficult for us to sell. We had to sell our face to nail a deal. At Bayer, the products were purchased patents, but they did not send the product from Germany. Our product was no different than the other national products. For example, only Taiwan is producing methamidaphos these days. Bayer buys from them like all of the rest.

Companies encouraged heightened sales through financial rewards and other incentives:

> I did so well that they sent me to Cartagena as the best salesman. Yep, I went to sleep eight nights in Cartagena. Colombia was the destiny when you won an award, because Dow and Novartis were in Colombia. Three times I was selected the best vendor at the national level.... I gave my life to the company. I spent the day in the store and the nights in the communities. I was trying to convince the people to buy my products. I have always been a perfectionist. I was more perfectionist that my German boss. They loved me. The job was motivating. The more you worked, the more you earned.

When asked who was responsible for the problems associated with pesticides, a salesperson in San Gabriel responded:

> The same salespeople are responsible. Sure they worry about burning a farmer's field, but they worry more about not selling that litre. So they know the farmer only needs 400 ml to cover his field, but if I sell him a litre that shouldn't burn his field, and I will have nailed another litre of product. Everyone wins – he cures his problem and I sell my litre… Being ethical only pays if you are going to be around for a long time.

In practice, pesticide sales were less about helping farmers to solve their problems and improve production than wealth extraction from farmers as a means of accumulation for salespeople and their companies.

Refusal to eliminate highly toxics or promote pesticide-use reduction

In addition to the difficulty of reaching more than a small percentage of farmers with training, diverse international organizations, including FAO, USAID, World Bank, and Novartis, have concluded that SUP campaigns – the cornerstone of Ecuador's policy response to acutely toxic pesticides – are ineffective. Through focusing on managing the effects (i.e., exposure), rather than the fundamental cause (highly toxics in the environment), SUP may please policy makers, but it does little to prevent intoxications in rural communities. Farmers regard PPE as uncomfortable and "suffocating" in humid warm weather, leading to the classic problem of compliance associated with individually oriented exposure reduction approaches (Murray and Taylor, 2000).

The research in Carchi reconfirmed the ineffectiveness of SUP. Even when PPE was used, product isolation was deemed difficult to impossible in the open environment of field agriculture, where farming infrastructure and housing were closely connected and exposure inevitable. Well aware of this reality, the occupational health literature (Plog et al., 1996) as well as industry studies (Atkin and Leisinger, 2000) agreed that the most promising means of addressing pesticide exposure problems was one single measure: eliminating the most toxic compounds from the work and living environments.

Initially, the industry proposed to work through INIAP's IPM program in Carchi, which centred on Farmer Field Schools. Joel, the head of INIAP's provincial office and its IPM champion, was a staunch advocate of FFS as a means to pesticide-use reduction. Joel told me that he was not against receiving funds from CropLife, as long as INIAP could conserve its independence and run the project "technically," which meant FFS would be used as a means to reduce pesticide use and in particular the elimination of the highly toxics. After learning about this, CropLife's representative informed us that he could not finance a project that promoted pesticide-use reduction. Instead, he proposed that the industry complement INIAP's FFS training with SUP. Seeing the contradictions between SUP and FFS, Joel turned down the offer stating, "INIAP will never work with CropLife in Carchi." When Joel accepted a two-year leave of absence to enter a MSc program, however, the door opened for new INIAP leadership in Carchi and policy change.

Shaping the State

> All the specialists we consulted, including from the Ministry of Agriculture, argued that less toxic pesticides were equally effective [as the more toxic products]; and as a result, they argued that the country should not wait to prohibit the importation of products classified as extremely dangerous. – Rodolfo Asar, *Día a Día* programme

On the surface, government officials maintained a discourse against the highly toxics and in favour of public health. For example, in mid-2001, INIAP was prepared to declare that alternative technologies existed for the Andean weevil and foliage pests and that highly toxic pesticides were not necessary for potato production and other highland crops.[16] Nevertheless, the industry continually mobilised to block such proposals.

The BBC met with Carlos Navas, the Head of Pesticide Product Registration and Regulation at SESA in the Ministry of Agriculture, to ask him one question (BBC, 2004): "Does Ecuador need these dangerous [red label] chemicals or should they just be banned?" Navas answered:

> We need scientific support to conduct studies in order to complete the forms for prohibiting the importation or manufacture of certain products. As well as scientific and technical support, we need substitutes for certain pesticides. And when alternatives become available, then we can replace the product and ban the use of dangerous pesticides, but there is no possibility of doing that without new or different products.

Navas, the man who could ban pesticides, was an active member of the National Pesticide Committee and therefore was knowledgeable with the research outcomes in Carchi, including the existence of alternatives. Nevertheless, he had adopted essentially the same position as the industry: all pesticides were indispensable. The industry's penetration of MAG dated decades, so SESA's allegiance came as no surprise. At CIP we were surprised, however, to discover that our long-time collaborators at INIAP were similarly vulnerable.

Since 1991, Vicente had become the principal government partner of the CIP-led pesticide research in Carchi. He proved an invaluable ally, capable of navigating the complex government bureaucracy and getting things done in the field. Later, I would learn that he also was an old friend of FMC's National Sales Representative and CropLife-Ecuador's treasurer. Their history extended back to university, the National College of Agronomists, and family. Vicente was an economist and self-described pragmatist. He once told me that when it came to projects, whatever functioned or worked became the truth. As Head of INIAP's Technical Assistance Unit (in Spanish, NAT) in the highlands, he was formally in charge of the Institute's interface with farmers and communities. He became respected throughout INIAP as a strict disciplinarian. One of his colleagues told me, "Vicente knows how to make his people toe the line." Additionally, Vicente was effective at "capturing funds" from donor agencies, which won him much esteem and appreciation at INIAP, particularly when the Institute suffered funding cutbacks as a result of Ecuador's "government modernisation" policies of the late 1990s.

At the end of 2001, Pumisacho and I contracted Vicente to conduct an in-depth case study on the impacts of the Farmer Field Schools in Ecuador. Unbeknown to us, Vicente would make a secret pact with the industry to co-publish the impact of its interventions in Carchi. While CropLife refused to finance FFS because of its emphasis on pesticide-use reduction, it was eager to link up with FFS as a result of the methodology's growing popularity. When I informed colleagues at the Global IPM Facility of the cooption of

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[16] Gustavo Vera, INIAP Director of Research, personal communication.

FFS, they informed me that the industry had applied similar tactics elsewhere.[17] By the end of 2002, Vicente, and thus INIAP, explicitly joined forces with the pro-pesticide alliance, proclaiming, "We need the resources."[18]

The Eco*Salud* project ended in 2001, creating a funding void. In February 2002, Manuel Pumisacho and Vicente came to my home to discuss potential conflicts of interest with a proposed CropLife project in Carchi. We talked about the primacy of pesticide-use reduction as well as Joel's negative experience with CropLife over FFS. Additionally, I provided them with diverse documentation on the problematic nature of public-private collaborations over pesticides, including highlighted sections of the FAO's Code of Conduct, the WHO's hazards policy, and the World Bank's IPM policy guidelines. When they left, I thought we had agreed that INIAP should keep a safe distance from the industry.

Several weeks later, however, CropLife invited Vicente to a global SUP meeting at a luxurious five-star hotel in Miami, Florida. Included in that meeting was an expert from the FAO's pesticide program who sold Vicente on SUP and public-private collaboration over pesticides, citing the FAO's collaboration with CropLife as well as that of the International Fund for Agricultural Development (IFAD).[19]

CropLife-Ecuador highlighted its "strategic alliance" with INIAP in its 2002 annual report, including a photograph of the signing at the Santa Catalina Research Station and a summary of its innovative public-private partnership to promote SUP in Carchi:

> Through the project "Correct use and management of crop protection products and integrated pest management" we propose to overcome the limitations of the [development] work-to-date by improving human health and the conservation of ecosystems. The project proposes a series of strategies that serve as a support to the activities of a sustainable agriculture, in such a way that it achieves an abundant food production by efficient and responsible means, thereby fulfilling the basic norms of security for man and the environment.

The central objective of the proposal was "to promote the importance of correct use of CPP [in English, Crop Protection Products] and IPM" as well as "to train farmers, housewives and *técnicos* in CPP and IPM."[20] The project employed the Scarecrow design of training primary school teachers and children so that they would "grow up with clearer criteria with respect to using pesticides."

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[17] See for example, Bayer Corporation's evocations of IPM and FFS in Courier Magazine, Special Issue 1997. In 2007, Bayer would employ essentially the same tactics in Peru.

[18] Personal communication.

[19] IFAD and CropLife, 2001. "*Una iniciativa publica-privada en pro del desarrollo*," 16 pp.

[20] Sources at INIAP in Carchi said that due to criticisms over "Safe Use of Pesticides," it had decided to use the term "*Uso Correcto de los Productos para la Protección de Cultivos*" (in English, "Correct Use of Crop Protection Products"). Nevertheless, the change did not include a re-thinking in training content, other than a linkage with IPM. Later, the Director of INIAP informed me, "We know and understand the inter-institutional politics against the 'indiscriminate' use of pesticides. Our institutional policy is *adequate* use of the same [pesticides], according to established schemes that you know very well."

After learning about this, I sent an e-mail message to Vicente and Lorenzo, the head of INIAP's Santa Catalina Experiment Station, outlining my concerns.[21] In it, I highlighted a number of contradictions between earlier INIAP studies, which concluded that "highly toxics could not be safely used under the socioeconomic conditions of Carchi," and the central design of INIAP's new initiative with CropLife. Vicente responded that he had the full support of the INIAP's Directors, and he threatened me with legal action for "placing into question his honour."[22] A week later, the Director of Santa Catalina sent me a follow-up message stating:[23]

> With much preoccupation I have read the electronic message you sent to Vicente... in reference to the relationship between INIAP and CropLife. I should indicate to you that the relationship is institutional – EESC [the Santa Catalina Experimental Station] with CropLife – more than personal – Vicente-CropLife.

The head of the research station went on to defend the decision:

> ...The relationship between INIAP and Crop Life does not represent a conflict of interest, and worse an anti-technical and more so anti-ethical relationship, terms that I reject up front due to our morally technical training that we have received in our institute during the length of our professional career.

Citing an unspecified IFPRI study on the value of public-private collaboration, the Director General of INIAP subsequently informed me that the organization had ample justification for working with the pesticide industry and that he personally had supported the agreement. By then, an industry *técnico* had long ago moved into the INIAP office at San Gabriel, under Vicente's direct supervision. Despite the obvious contradictions with INIAP's earlier research and especially Vicente's own publications, CropLife and INIAP had agreed to work together on SUP, thereby safeguarding the market for all pesticides – including the highly toxics.

Similarly, in 2004, the FAO financed a project that ignored the studies on the problematic nature of SUP and the priority of eliminating highly toxic pesticides (Box 7.3). Maria, the earlier mentioned toxicologist from SESA who lobbied on behalf of the Carchi Declaration, was in charge of this project. Since the national forum in Quito, the industry had financed her extended sabbatical in Switzerland. Upon return to Ecuador, her position shifted from "the elimination of highly toxic pesticides" to the "correct use of pesticides."

Growing public awareness over the pesticide-induced epidemic in Carchi combined with the explicit approval of MAG, SESA, INIAP, and the FAO of the pesticide industry's activity raised doubts over the integrity of public authorities and their institutions. Such examples provided fodder for competing organizations, such as the Pesticide Action Network and the *Coordinadora Ecuatoriana de Agroecologia*, as they organized to call attention

[21] Electronic mail correspondence, 11 March 2004.
[22] Electronic mail correspondence, 13 March 2004.
[23] Electronic mail correspondence, 22 March 2004.

to the complicity of *técnicos*, government, and international organizations in the promotion of harmful technology.

Box 7.3 The FAO finances the pro-pesticide agenda in Ecuador

In April 2004, the FAO financed a one-year, $230,000 project entitled, "Support to the application of the Specifications of the International Code of Conduct in the Registry and Control of Pesticides" in collaboration with SESA (FAO/TCP/ECU/2903). The objectives were to train SESA personnel in "the correct use of pesticides" and to "contribute to the harmonization of legislation associated with the International Code of Conduct for the Distribution and Utilization of Pesticides." More specifically, the project sought to train the SESA staff in the FAO's Code of Conduct over the Distribution and Utilization of Pesticides, the registry of products, and laboratory skills in testing for pesticide residuals in food. The project emphasized the percentage of active ingredient as the "indispensable requisite" for product registry. It also sought to improve the registry of pesticides through quality control of agricultural products using pesticide residuals on commodities as its indicator. It did not take into account socioeconomic exposure conditions and the resulting health effects on rural populations. Its environmental studies were limited to a study on the use of pesticides in order to produce a national system of monitoring pesticide use and a database of registered agrochemicals. This included recommendations for the elimination of pesticide containers. The project also produced technical recommendations for the Ecuadorian government on the fulfilment of the FAO's Code of Conduct. Through this project, the FAO's position became essentially identical to that of Crop Life.

Rise of dissent

Divergence: breakdown of allegiances

Pro-health alliance

The decision of NAT to collaborate with CropLife was not universally accepted at INIAP. The Head of the National Potato Program told me the decision "went against recent advances towards clean production." Further, the leader of the Legume and Quinoa Program believed, "The CropLife collaboration jeopardized our program on organic agriculture." Both mentioned that collaboration with CropLife could perpetuate negative stereotypes towards INIAP as "stuck in the green revolution," despite many recent changes.

Knowledge of the INIAP-CropLife collaboration reached a number of research and development organizations working in Carchi, including CIP, Randi Randi, Eco-Par, and the Network for Community-Based Natural Resource Management (MACRENA). CIP found the contradictions of the INIAP-CropLife collaboration irreconcilable and informed INIAP and IDRC that if the collaboration carried on, CIP would have to discontinue its work with INIAP in Carchi.[24] Nevertheless, due to its mandate to support INIAP, the leadership at CIP-Ecuador felt it could not altogether sever ties with the organization. Instead, it re-centred the Eco*Salud* around nutrition and moved it to the Central highlands. In response, Vicente declared that he and his unit would not collaborate with Eco*Salud* in Carchi or anywhere else. As a result, the second phase of Eco*Salud* became more closely aligned with non-INIAP actors, including local universities, NGOs, and CBOs and moved to less controversial regions where pesticide exposure was not a major concern.

Having won the allegiance of SESA, INIAP, and FAO, CropLife attempted to enlist the provincial offices of the Ministry of Agriculture. Nevertheless, Freddie, a MAG extensionist, and MAG's Provincial Director remained committed to the pro-health agenda. When asked about this, Freddie explained that the FFS Training of Trainers was a "profound personal experience, which fundamentally changed my view on things." He mentioned, "In the absence of Joel, INIAP was quick to sell-out." Meanwhile, the Provincial Director with MAG, Federico, was a recent political appointee, so he had no long-term ties to the Ministry. Additionally, he explained, his background with the Humanist Movement led him to view pesticides as a means of violence.

INIAP and CropLife attempted to enrol municipalities, grade schools, and NGOs in Carchi. Nevertheless, local dissent blocked municipalities from signing letters of agreement. A project leader from EcoPar explained that despite her willingness to work with INIAP, as a result of INIAP's collaboration with CropLife over SUP, her professional and organizational commitments to environmental interests would not permit her to work with the Institute in Carchi.[25] Similarly, the situation obligated me to personally break ties with INIAP as well as the FAO in Ecuador.

Pro-pesticide alliance

During a Bayer-sponsored event, a colleague at CIP and I spoke with the Bayer representative for Latin America. We asked him about the company's continued sale of methamidaphos in Ecuador. He said that while methamidophos was important for Bayer in the 1970s and 1980s, in recent time the German public had become very demanding over environmental and health concerns, and the company was making an effort to respond with "safer, green label products." In fact, the public demanded that companies only sell abroad products permitted in Germany. He explained that Bayer was making an effort to distance itself from its older, "red label" products. He said that Tamaron, Bayer's commercial formulation of methamidaphos, represented less than five percent of its sales in Ecuador. As such, Bayer felt that the continued sale of methamidaphos brought "little profit, and high liability." He thought that it could be of strategic value for Bayer to distance itself from such risks by removing its red label products from markets in the developing world. This, he explained, would allow Bayer to focus on its newer and safer products.

[24] Personal communication with Donald Cole, the EcoSalud principal investigator and Graham Thiele, CIP-Ecuador, 24 May 2004.
[25] K. Ambrose, EcoPar, personal communication, 5 April 2004.

The APSCA representative in Ecuador confided to me that the Ecuadorian companies had formed a block against the international companies. The national companies relied on sales of generic (and especially red label) products that were off-patent, signifying that third parties could legally synthesize the active ingredient and repackage and sell it as new, competing products. The companies purchased these active ingredients and formulated their own products that were often of lesser quality but considerably cheaper than the products of the original manufacturers. For example, the national company Ecuaquimica sold the commercial product Carbofuran at 20 to 50 percent below Furadan – FMC's commercial formulation for the same metabolite carbofuran. Similarly, off-patent formulations of methamidaphos commonly sold for about 30 percent less than Bayer's commercial product Tamaron. Over time, the national industry had gained growing market shares around the sale of old products and, as a result, had come to financially depend on them.

I was privately told that after a Bayer representative suggested publicly distancing itself from methamidophos, the national pesticide industry threatened to block the company's access to the Ecuadorian market. Provided that the political elite was involved with the national pesticide industry, including an ex-President and Head of Congress as well as numerous other influential public officials, there was no doubt that the national industry could create difficulties for even a powerful international company.

In July 2004, I was surprised by an e-mail communication from a confidant in INIAP informing me that, "EESC has reconsidered its work with CropLife, and INIAP has made a clear step to sever its ties with the pesticide industry." The message went on to explain that NAT would fulfil its current contractual obligations with CropLife through March 2005, and that the arrangement would not be renewed thereafter. Several days later the FAO Country Representative shed light on the factors behind INIAP's new policy. He told me that he had just returned from a meeting with industry representatives in Guayaquil and learned that a rupture had developed between the national and international industry over the sale of generic products.

A newspaper article appearing shortly thereafter provided further details (Box 7.4). In brief, the Ecuadorian industry had decided to disassociate itself with the international companies over the right to purchase generic active ingredients for local formulations, as part of the US-led Fair Trade Agreement (FTA) negotiations. Even though the FTA provisions would apply only to new products,[26] the motion was sufficient for the national industry to want to withdraw its support to the CropLife-led campaign in Carchi. In the article, the President of CropLife-Ecuador had reverted back to using the previous name of his organization: APSCA. As a result of this conflict, INIAP's collaborative SUP project temporarily ended.

[26] Allan Hruska, FAO regional IPM specialist, personal communication on 1 August 2005.

Box 7.4 The pesticide industry clashes over the sale of generic products[27]

A major concern for pharmaceuticals and agrochemicals of the US-supported "Free Trade Agreement" in Ecuador was the free sale of generic products that, while cheaper for consumers, was anathema to international corporations. Patent laws governing intellectual property rights over pesticides allow a company monopoly control over its product for a period of 17 to 20 years, depending on the date and country where the patent was filed.[28] Once a product becomes off-patent, essentially anyone with the know-how can copy the chemical formula for an active ingredient and sell it on his or her own. Asian countries with highly developed chemical industries, such as China and Taiwan, make hearty profits from the sale of active ingredients from expired chemical patents, much to the benefit of independent companies in lesser-developed countries.

Since 1996, a number of Ecuadorian companies have imported active ingredients from third parties and reformulated them as new pesticide products. Often this results in a product that is of similar quality than the original at a fraction of the cost. As a result of the 250 percent inflation that followed dollarisation, in March 2000, sales of generic products increased dramatically due to their comparative advantage in cost, and the Ecuadorian agrochemical industry became increasingly dependent on the reformulation and sale of off-patent products. Of the 30 most popular pesticides in Ecuador, all but one had an expired patent, and essentially all pesticides used on potato production in Carchi were off-patent.[29] The Ecuadorian industry claimed that between 1996 and 2003, it had saved producers over $240 million in pesticide costs through the provision of cheap products.

In April 2004, the United States delegation on Free Trade Agreement (FTA) negotiations demanded an increase on restrictions of the sale of generic agricultural products in the Andes, calling for a ten-year period of exclusivity on new products, followed by five additional years of royalties. The US negotiators maintained that this was justified for industry to recover research costs and to assure incentives for continued product development. The US drew on private negotiation strategies to successfully push through such provisions in Central America and Chile.

“In solidarity with Ecuadorian producers,” the national agrochemical industry decided to break with CropLife-Latin America. As a result of the conflict over generics, CropLife-Ecuador temporarily reverted back to using its original name: the National Association of Plant Protection and Animal Health Industry (APSCA).

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[27] Based on: "*Más costo al agro? Un mercado de 126 millones se pone en debate.” El Comercio.* Saturday, 7 August 2004. Section B-1, Agromar. Also see, Gaybor, Nieto, and Velastegui (2006).
[28] Previously, patent protection for agrochemical products in the US was 17 years, but recently it was increased to 20 years. For more information see: http://www.uspto.gov/web/offices/pac/mpep/consolidated_laws.pdf
[29] According to SESA’s pesticide registration database, of the 30 leading pesticides sold in Ecuador, only the fungicide trifloxistrobin is under patent with the German company Bayer.

Reactions

> The government says that it does not have the research or the resources to take action on the most toxic pesticides, and the chemical companies say they cannot control how products are used in the field. So, it seems that the farmers will have to take measures to help themselves... – *Dying to Make a Living*, BBC World Service

Ulrich Beck (Beck et al., 1994: 22-23) distinguishes sub-politics from politics in that agents lying outside the political or corporatist system appear on the "stage of social design." He describes how sub-politics shape society from the grassroots, involving the citizenry, social movements, expert groups, and even courageous individuals who temporarily step outside the norms of their organizations, often at great personal risk. Sub-politics may arise spontaneously, often out of the wake of emotional events such as environmental disaster or disease events when people feel intimately, if not unfairly, affected by the external environment. Beck argues that modernity's tendencies towards individualization and globalization foment the rise of sub-political movements in response to a sense of fragmentation between the formal political agenda and peoples' lives.

Chapter 4 revealed how modern technology caused nature to reach its biological limit in Carchi to the point where agrochemicals and mechanized tillage were transformed from symbols of abundance and freedom to tokens of scarcity and debt. This generated growing natural and societal forms of rebellion. From an environmental perspective, agricultural intensification led to increased pest and disease outbreaks as well as soil degradation. Government-encouraged growth of the agricultural frontier led to destruction of forests and the *páramo*, interrupting hydrological systems and drying up water sources. Over time, the famously robust environment of Carchi and its markets began to turn on farmers, and farmers turned on government and authority.

Local movements

Some people blamed themselves for modern productivity declines, for example, when a farmer from San Gabriel privately told me, "We are *brutos*. They gave us the land, and we destroyed it. Now, we are all going to have to migrate to the cities." A growing number, however, began to look more critically at their recent history, which led to protests against the government and professionals. Paredes (2001) found that this was particularly true for FFS graduates. During a meeting on pesticide health effects in El Angel, an FFS graduate stood up and shouted, "First the *ingenieros* told us to use agrochemicals. Now they are telling us not to use them. Whom are we supposed to believe?"

Escalating concern over the general situation fuelled protests. In November 2003, entire communities descended from the mountainsides to the Pan-American Highway demanding that the national government declare the province a "state of economic and agricultural emergency" (Box 7.5). The district *Centro Agrícola* from Montúfar and Espejo led the protest. They demanded attention to the pest and pesticide crisis, control over Colombian contraband, subsidized credit, seed, fertilisers, and machinery. The strike grew to nearly 10,000 participants, eventually shutting down the province as well as trade between the countries of Ecuador and Colombia.[30]

Box 7.5 Potato farmers take the Pan-American Highway[31]

Faced with falling potato prices, growing pest problems, and increasingly aware of the health effects of pesticides, the farmers of Carchi were moved to protest in late 2003. The leadership of the county agriculture centres of Montúfar and Espejo won the support of the Provincial Governor and farmers elsewhere. In a letter to President Lucio Gutierrez, they demanded that Carchi be declared a zone of "agricultural and economic emergency." Farmers sought controls over the importation of potato and milk from Colombia due to unfair competition as a result of dollarisation. They also demanded technical assistance, machinery, inputs, seed, and credit.

In response, the President signed a decree declaring the banana sector of the Province of El Oro and other agricultural sectors in a "state of economic emergency." The farmer leadership of Carchi called the decree a betrayal. On the 5th of December, they gave the President 24 hours to respond to their concerns, else they would close down Carchi indefinitely. Several days later, they lived up to their threat and thousands of farmers blocked the Pan-American Highway, the single artery connecting Ecuador to Colombia. The highway remained closed for five days, until the rains came and the participants returned to their communities for planting season.

The Sub-secretary of the Ministry of Agriculture, who was assigned the task of quelling the protest, told me that it was difficult to negotiate with the farmers because, "They seemed to be angry about everything."[32] In the end, the Government offered to donate several tractors from the Chinese government, but according to one of the leaders, little else was accomplished.[33]

Following the strike, community organisers from the Humanist Movement arrived with the intention of blocking CropLife and INIAP's efforts to recruit municipalities onto the SUP agenda. Together with FFS graduates, EcoPar, the Carchi Consortium and MACRENA, the Humanist Movement sought to expose the contradictions of public collaboration with the pesticide industry and the proposed SUP campaigns. Through dozens of in-depth workshops in communities and stakeholder meetings with municipalities, the public deepened its understanding of the pesticide crisis. Subsequent activities in the counties of Montúfar, Espejo, and Mira led to a boycott of the proposed.

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[30] Personal communication with Juan Carlos Landázuri, President of the *Centro Agrícola* of Montúfar, 12 December 2001.
[31] Dos opciones para superar el conflict en Carchi. El Comercio, 5 November 2003.
[32] Personal communication with Fausto Merino, Sub-secretary for the Highlands and Amazon, Ministry of Agriculture, 12 January 2002.
[33] Juan Carlos Landázuri, 12 December 2001.

CropLife-INIAP activity[34] as well as municipal ordinances against the sale of highly toxics in Espejo and Mira.[35]

Agroecologists and environmentalists

The news of INIAP's collaboration with CropLife arrived at the National Coordinator of Ecological Agriculture (CEA), a network of NGOs and CBOs, including the Pesticide Action Network (PAN-Ecuador). Following a series of meetings in March and April 2004, CEA and PAN-Ecuador drafted a position statement to the Director General of INIAP.[36] The letter highlighted the World Bank and the industry's own conclusions on the Safe Use of Pesticides, stating, "The promotion of safe use of highly toxic pesticides is at best irresponsible." The letter cited the previous INIAP and CIP research emphasizing, "INIAP should play a more pro-active role in research for the elimination of highly toxic pesticides." Further, the CEA went on to question INIAP's collaboration with the industry: "There exists a conflict of interest between the commercial priorities of the pesticide industry and the public mandate of INIAP." The letter closed by demanding that INIAP "terminate its contract with CropLife" and that it "focus its research on decreasing dependencies on pesticides and especially the elimination of highly toxic products."

The CEA organized a Congress in November 2005, to update the national agroecology agenda. A discussion table dedicated to pesticide concerns, which included about 60 representatives of organizations from the coast, highlands, and the Amazon, produced the "Declaration of Active Non-complicity in the Use of Highly Toxic and Dangerous Pesticides," calling for:[37]

- information campaigns on the human health and environmental affects of highly toxic pesticides
- boycotts on produce, such as tomato, potato, and banana, that does not include guarantees that they were produced without dangerous pesticides
- demands that the government label produce that has been produced with highly toxic pesticides
- demands that public entities, including SESA, INIAP, the Ministry of Education, municipalities,, and provincial governments, do not collaborate with industry-led SUP campaigns; rather they should support campaigns centring on the reduction of use of pesticides and, in particular, highly toxics
- linkages between Ecuador and similar initiatives elsewhere in Latin America, Europe, and the United States for the elimination of dangerous pesticides

In 2006, the bilateral negotiations between Ecuador and the United States over the Fair Trade Agreement subsumed health concerns over pesticides. CEA, PAN-Ecuador, and partner organizations reorganised around intellectual property rights and national

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[34] Personal communication with Luis Gonzalez, Project Expert, EcoPar and advisor to the Environmental Unit for the Municipality of San Gabriel, 11 August 2005.
[35] Personal communication with Mauricio Proaño, President, Grupo Randi-Randi, 11 August 2005.
[36] Letter to the Director General of INIAP, Ecuadorian Coordinator of Agroecology (CEA) and the Pesticide Action Network, 17 May 2004.
[37] CEA, Proceedings from the National Congress on Agroecology, Quito, Ecuador, 27-29 November 2005.

sovereignty, controversial issues that were not inconsistent with the aforementioned demands of private industry over the sale of generic products (Box 7.5), leading to unusual alliances and wide scale criticism of the FTA negotiations. The Ecuadorian System of Training on Management of Renewable Natural Resources (CAMAREN) published an investigation that concluded, "...the FTA does not provide a competitive market for pesticides, inputs that are widely used in Ecuadorian agriculture. On the contrary, what is sought [by the FTA] is monopoly control over markets" (Gaybor et al., 2006: 128). By the end of the year, the FTA negotiations were successfully blocked, but the open sale and distribution of highly toxic pesticides continued.

Modes of enactment: determining technology in Carchi

> The public interprets science; it does not misunderstand it. – John Law (2004: 2)

The pro-health lobby produced information that exposed serious human health, productivity, and environmental problems associated with highly toxic pesticides. It argued that under the socio-economic conditions of Carchi, safe use of the highly toxics was an impossibility, with or without SUP practice. Studies elsewhere, including those of the industry, concurred. The pro-health lobby also provided substantial quantitative and qualitative evidence supporting the viability of alternatives, such as the Farmer Field Schools in IPM. Despite such contributions, the policy in Ecuador continued to be: the highly toxics *should not* be banned. Further, it became accepted that the highly toxics essentially *could not* be banned. How did this occur?

<u>Enrolment and alliance building</u>

> Let's work together. – a Bayer Corporation slogan[38]

Latour and Woolgar (1979) describe enrolment as a process of "inscribing" interests into new symbols with mutually acceptable meaning. Once inscribed, translations can be manipulated and transferred – they become socially mobile. This process leads to the creation of new co-constructions or naturecultures. Mol (1999) suggests that the aim of enrolment is not to merely describe or tell, but to influence a body or a life. In the case of Carchi, a whole set of practices were involved in the co-production of pesticide-dependent agriculture. These emerged through a number of means, particularly truth construction through translation of prestigious symbols.

Expert black-boxing: torredor *of truth*

> We understand that there are people who approach pesticides with a different ideology and we accept that. I am sorry that our visitors had to leave so promptly, because I wanted to thank them for adding some excitement to my presentation. I know how fond people in Ecuador are of bullfights, but sometimes it is difficult for me to know whether I am the bull or the *torredor*. – Director of Global Regulatory Affairs, FMC Agricultural Products

[38] Bayer Corporation. 1997. *Courier Magazine*. Special Issue on IPM. 23 pp.

In its questioning of the status of information on pesticides, the pro-pesticide alliance adopted a view of science as one unified, unquestionable body of knowledge. In so doing, it classified alternative perspectives as *other*, i.e., outside of the accepted reality and therefore unreal and invalid. Further, the alliance cited prestigious individuals and institutions, such as the Director General of the FAO, in support of its claims.

Through establishing a dichotomy between "backward" rural societies that needed "modernisation" and "food security" by a centre of power, the need for outside intervention was legitimized. This justified the priority of transforming ruralities through "improved technologies." The pesticide industry, public officials, researchers, and farmers commonly argued that the highly toxics were necessary for production and that no viable alternatives existed. While commonly accusing the opposition of being "romantic" and "ideological," the pro-pesticide alliance commonly nurtured ideology of its own, particularly around the value of technology for "feeding the world" as well as the notion of "safe-use" of pesticides.

Latour (1987) makes a compelling argument about the "constructedness" of science, i.e., how scientists or experts strategize to create truths. Far from submissive actors who obediently follow pre-established protocols, they present scientists as "entrepreneurs" capable of indiscriminately pursuing political and economic objectives. Focusing on the early stages of scientific process, they describe how scientists create oversimplified abstractions or "black boxes"[39] around their activity and organize to enrol others into support networks.

The experience in Carchi demonstrates how similar activity occurred in the realm of ready-made agricultural technologies. Pesticide technology was built on Latour's mythical "black boxes": what people come to rely on but do not question. Black boxes became a way of managing the complexities of biological and social worlds associated with farming. Relatively closed socio-technical systems were simplified to structures of black boxes that legitimized new practices and rule systems on problem definition and solutions (e.g., purchase, application, mixing, etc.), and it established new mediating roles, with agricultural researchers, extensionists, and agrochemical salespeople as key knowledge brokers. This may have been good for generating new industry, but eventually it proved to be bad for the environment, food production, and society.

Instead of revealing insights into how to autonomously manage ecologies, the experts framed phytosanitary problems around urgencies, many of which were generated by modern technologies themselves. (This later fact was systematically deemphasised.) The effect was a shift from management to "control" as a priority and the knowledge of the *técnicos* and their pesticide technology as the "saving grace."

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[39] Latour (1987:2) borrows the term 'black box', a metaphor that cyberneticians use to simplify highly complex machinery. He explains that, "They draw a little box about which they need to know nothing but its input and output." Throughout the experience presented in this chapter, many aspects of agro-biology (e.g., insect and disease cycles, 'pests', and soil biota) and agrochemicals (chemical fertilizers and pesticides) were effectively 'black boxed' by science and technology brokers. Arguably, such activity represented attempts to turn farmers into passive operators of technology.

The disposition of science – in this case, the pesticide industry and a national research institution – to ignore obvious contradictions shows that more important than adherence to research claims was the motivation to create new truths that were in line with evolving purposes. Over time, the multiple black boxes that bolstered pesticide technology effectively came to blind many farmers to the past as well as other alternative farming realities. Farmers prioritised the proscribed corrective inputs (basic purchasing and application knowledge) and outputs (quick, convenient ways of killing pests) deemed necessary for "economy" and "security." In the process, millennia of experience on "feeding" the plant and the soil became supplanted.[40] Over time, the environmental and social systems co-evolved to the point where farmers became dependent on external actors and their technology, thereby charting an indelible course for the future: more of the same.

Processes of translation

The industry in Latin America has long drawn on a tactic of framing the pesticide problem as one of "perception" and "radical ideals" of urban-based environmentalists, rather than one of substance (Jansen, 2000; Murray and Taylor, 2000). One means of achieving this in Carchi was through interpretation of experience and translation of meaning.

The pro-pesticide alliance went to great lengths to reinterpret the research outcomes and to transform concepts such as toxicity and intoxication for the public. During an INIAP and CropLife organized course for university students, a CropLife training specialist argued that pesticides "actually were no more dangerous than water" and equally essential for life (Box 7.6).

Box 7.6 "Pesticides are as safe as H_20"

During an INIAP-CropLife course for university students, Arturo, the CropLife employee in Carchi, gave a four-hour session on Safe Use of Pesticides. To open, he drew out the basic chemical formula of H_20, water, on a whiteboard and asked the class, "What are the dangers of this chemical?" Assuming that the formula belonged to a chemical pesticide, people in the class volunteered responses, such as: "It kills beneficial insects;" "It pollutes water." Arturo said that despite the beliefs of the growing movement of "radicals" and "ecologists" in Ecuador, this formula was responsible for life and that no one in the class would be there if it did not exist. He explained that the formula was that of H_20 or water, which brought him to his point: "Chemical pesticides, like water, were essential for life."

Additionally, the pro-pesticide alliance organized to translate contested concepts, such as SUP and even pesticides, into seemingly more attractive euphemisms. I first learned of this when an INIAP field staff in Carchi explained to me: "We are not working with CropLife to promote SUP. We are working for the "Correct Use of Crop Protection Products." In 2002, we noticed that the industry and its associates similarly began to produce new nomenclature for SUP, such as "Correct Use of Crop Protection Products."

[40] Primavesi (1980) and Chauboussou (2004) provide scientific arguments behind the age-old rationale of working with (rather than against) biologies and ecologies to manage plant and soil health.

Meanwhile, the Bayer AgroVida project used "Management and Safe Use of Phytosanitary Products," which later became "Safe and Effective Use of Crop Protection Products."[41] Field staff at the INIAP office in San Gabriel and the Ministry of Agriculture (MAG) informed me that the change of language was made in coordination with CropLife; the goal of this activity was to continually "improve the image of the industry and appeal to a broader public."

A Brazilian woman and head of FMC's regulatory program in the region explained that the central purpose behind "the reengineering of concepts" was not to mask pesticides but to demonstrate that the industry was "acting with responsibility." She explained, "Each country uses it own name, but the philosophy is the same. What we want [to achieve] with this is to act in a responsible manner during all stages, from research, to registry, to product transport, product marketing and sales so that there is no other behaviour but responsible behaviour." In reference to the earlier described PAN-Ecuador protest, she added, "As we saw with our friends who we saw in the morning, with all of the pressure that we are facing, it is important because it is part of democracy and therein lays our challenge of continuing to improve and provide responses."

Eventually, the pro-pesticide alliance began to strategically link SUP with Integrated Pest Management, something that had happened years before in Southeast Asia.[42] This occurred at CropLife-International in Europe, CropLife-Latin America, CropLife-Ecuador, a public multinational (FAO-Ecuador), and the national government (MAG/SESA and INIAP). Beyond mere wordsmithing, the pro-pesticide alliance sought to create robust, publicly attractive concepts. Following my explanation of FFS as a means of "ecological literacy," a regional FMC representative explained to me that her company applied the same understanding to IPM:

> It is very important for us to include information on plant biology. For example, here I have [information on] cotton and potato. People also should have information on possible dangers [to the environment] caused by applying. They should also have information on biology because we also use Integrated Pest Management. We do not want only our products to be applied all the time. It is exactly the opposite.

She added, "We want that our product is applied at the necessary moment. It is very important to provide this type of information for people so that they know what is available for what pest and so they know of other FMC products, and not just Furadan." FMC utilised IPM to emphasize pesticides, including highly toxics, their "correct" and "responsible" use, and above all, the proliferation of FMC product lines.

An FFS graduate who participated in a CropLife course on "Integrated Pest Management and the Correct Use of Crop Protection Products" told me that they were treated well

[41] AgroVida course documents prepared by Bayer consultant, Dr. Alfredo Ramos Angel, Professor at ANDI and Specialist in Safe and Effective use of Pesticides.

[42] Personal communication, Kevin Gallagher of the FAO's Global IPM Facility in Rome and observed in Bayer Corporation, 1997, *Courier Magazine*. Special Issue on IPM. 23 pp.

during courses: "The food was much better than that during the training provided by [the CIP and INIAP-led] Eco*Salud* and the FAO [projects]." He added, "But we did not learn anything we did not already know."[43] When I asked him whether the project promoted the reduction of pesticide use, he said that they were being asked, "… to promote Safe Use of Pesticides. No one talked about not promoting a particular pesticide." Devoid of an emphasis on pesticide-use reduction, INIAP and CropLife essentially were using the term IPM outside its original designs and purposes. Such translation enabled CropLife and INIAP to claim that they were champions of the increasingly prestigious symbol of IPM.

In addition to IPM, the pro-pesticide alliance adopted the terminology of the agroecology movement, especially FFS (Box 7.7). As described in Chapter 6 and in Schut and Sherwood (2007), CropLife and INIAP came to value these approaches as prestigious symbols, but not necessarily their content, and they worked to transform such symbolism into the designs of the pro-pesticide alliance. INIAP and CropLife co-produced a greatly reduced version of the Farmer Field School methodology that consisted of five, two-day sessions over several months designed to "teach farmers technologies, so that they would in turn teach them to other farmers in their communities." This training of trainers was substantially less intensive than the 400 plus hours that had become the standard in Ecuador. These "Farmer Field Schools" also did not include essential processes of the methodology, such as learning plots, agroecosystem analysis, and open-ended experiments. As a result, the transformed FFS operated outside the proposed epistemological boundaries. The strategic distortions of concepts such as IPM and FFS demonstrated that the pro-pesticide alliance indiscriminately utilized approaches and methodologies to advance its purposes.

Building allegiances

According to Star and Griesemer (1989), "boundary objects" cross into intersecting worlds, satisfying the informational needs of each. Boundary objects are both robust enough to encompass needs and plastic enough to adapt the local needs and constraints of involved parties. In addition to continual processes of black-boxing, translation, and the cooption of prestigious symbols, the utilization of boundary objects became a means of socializing specific perspectives and building allegiances. Each boundary object had a different meaning for each actor, but their gradual emergence slowly facilitated the construction of collaborative platforms and continual claims to truth, impact, and public advocacy (Box 7.8). Within these constructs, the interests of actors slowly became transformed and assimilated into evolving networks of influence.

The pesticide conflict played out as a battle, with the protagonists attempting to get more and more allies on their side. As such, the enrolment of actors became central to success. Most of us assumed that CropLife had enticed INIAP with project funds, but when we learned the amount – $6,000 for the first year and up to $12,000 thereafter – we realized that their relationship was built on another foundation. As described earlier, we discovered that the Head of NAT had long-standing personal and professional ties with people at FMC and CropLife. Further, having lived first-hand the decline of public

[43] Personal communication, 10 April 2003.

support for research and extension and observing the climb of the agrochemical and flower industries, many agriculture professionals long before had reached the conclusion that the future lay in ties with private industry.

Box 7.7 Gaining ownership over FFS in Carchi

In mid-2003, I learned that INIAP planned to include CropLife's logo on the FAO-financed FFS impact study, which to me represented a dramatic pesticide industry "co-option" of FFS. I informed the Head of NAT of what I saw as conflicts of interest that I felt would lead CIP, FAO, and IPM-CRSP to withdraw financial support to IPM and FFS. He said that he did not agree, so I proceeded to consult others.

Officials at the FAO's Global IPM Facility (GIF) sent me documentation from the FAO and World Bank that articulated emerging policies against this sort of public-private collaboration. The GIF was careful to explain that, nevertheless, the policy was controversial and had not been fully accepted at the FAO. In May 2004, the head of the IPM-CRSP project, an economist at Virginia Tech, responded by e-mail, "We support your request that INIAP sever its ties to CropLife as we agree that our project does not wish to be associated with an organization that promotes the use of toxic Class I and Class II pesticides. We do not want our IPM-CRSP or the USAID logo on publications with the Crop Life logo or our money to be spent on joint activities with CropLife." He wrote INIAP informing it of the same policy. The Legal Representative of CIP-Ecuador explained that the CGIAR had not developed a policy. He asked CIP's Deputy Director of Research, an entomologist with a long history in IPM, to investigate the matter. She informed the Director General of INIAP that CIP did not collaborate with the pesticide industry and, like the IPM-CRSP, requested the CIP's logo not be included on the publication.

When the August 2004 publication appeared (Barrera et al., 2004), it included in order the following logos: CropLife, INIAP, IPM-CRSP, and FAO. As per its request, CIP's logo was not included. Not only did the Head of NAT include the IPM-CRSP's logo, but he also added two international project leaders to the list of authors. In the eyes of the public, the pro-pesticide alliance gained a degree of ownership over FFS.

Pressure groups educated themselves in their own perspective of the pesticide situation in Carchi and then mobilized to reify positions. A power centre, often organized around the interests of a prominent actor such as CropLife, emerged to challenge findings. At one level, the political battle over pesticide health effects became one of truth and truth-making. Eventually the pro-pesticide alliance made SUP its mobilization platform, followed by strategic action to tie SUP to prestigious symbols, claims of defending the public good, and public sanctioning through involvement of government agencies.

Box 7.8 (Mis)informing the public

On 3 September 2005, Ecuador's most widely read newspaper, *El Universo*, based in the country's largest city, Guayaquil, published an article with the title "Potato activity improves in Carchi: the indiscriminate use of crop protection products intensified the support of capacity-building entities, alleviating farmers difficulties." On 7 October 2006, the same newspaper published a second article, "Healthier crops at less cost." According to the people who were interviewed and cited in the articles, both authors worked in close coordination with the CropLife project coordinator in Carchi. The articles grossly misrepresented information, declaring that CropLife was "responsible for improvements in potato production" and "the alleviation of farmers' problems" as a result of its activities for "integrated and safe management" of pesticides. Examples from the articles include:

- "INIAP, the United Nations' Food and Agriculture Organization (FAO), the Bureau of Crop Life Industries (CropLife-Ecuador), the Ministry of Agriculture, and others supported farmers so that they could improve crop production, reduce costs, and improve management of agriculture inputs."
- "At this time, the Institute [INIAP] and CropLife are conducting experiments on the control of pests that attack the tuber in order to offer better alternatives in integrated and safe management of phytosanitary products with which they have been able to reduce problems by up to 40 percent."
- "As a result of its collaboration with CropLife, INIAP has been able to educate producers on the importance of utilizing the necessary dosage for particular pests and the protection for preserving the health of farmers. With this farmers have been able to reduce production costs by 30 percent."
- "More than 70 percent [of farmers] take necessary precautions in fumigating, storing, and destroying pesticide containers."
- "The leader of the CropLife project indicated that they have been working three and one-half years in the zone training farmers, housewives, and high school and university students so that they become aware of good utilization of phytosanitary products that are used in the province and that they create awareness among children."

The FAO and MAG did not directly participate in the initiative in Carchi, and in fact, MAG-Carchi explicitly opposed INIAP's collaboration with CropLife. As such, the article created an image of broad institutional support, thus falsely claiming a degree of public sanction for the INIAP-CropLife collaboration. The articles framed the problem in Carchi as a lack of "awareness of good utilization" of pesticides, here diversely called "crop protection" and "phytosanitary products." The health problem was framed as one that could be addressed through using "necessary dosage and protection." The concept of Integrated Pest Management became "integrated and safe management" of pesticides.

The cited data did not pertain to CropLife-supported Farmer Field Schools, but rather the CIP-supported Farmer Field Schools,[44] which were conducted from 1999-2002, prior to CropLife's arrival. As published in Barrera et al. (2001) and widely reported in Ecuador, the studies on the CIP-supported FFS showed that through more detailed knowledge of soils, insects and diseases combined with improved field scouting, farmers could reduce overall fertilizers use by 50 percent and pesticides by 46 percent (including a 75% reduction in the use of highly toxic products) without harming production per area, thereby contributing to decreased outlays and increased overall productivity by about 36 percent. In contrast to the information reported in the article, the most significant improvements in productivity did not come from pesticide use "improvements," but rather through decreasing fertilizer use and associated labour costs. The research suggested that farming changes may not have been primarily due to capacity building alone, but more so "dollarisation" of the national currency in 1999, which led to a triple digit inflation of agrochemical costs over the ensuing three years. No studies support the claim that 70 percent of farmers are taking necessary precautions to avoid exposure to pesticides.

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[44] From 1999-2002, Farmer Field Schools in Carchi were diversely financed by the IDRC-supported EcoSalud project as well as by USAID-supported IPM/CRSP, COSUDE FORTIPAPA, and FAO projects. The FFS during this period closely followed the methodology as established in Southeast Asia and outlined in Pumisacho and Sherwood (2005). These were co-designed and -implemented by CIP and INIAP-Carchi as well as by other local partners, including MAG, Randi-Randi, and independent local leaders.

Entrenchment through regulation

> In San Gabriel, there is not a single *ingeniero* who sells agrochemical products – just Pancho Leon [the owner of a store], who is never around. He puts cute girls in mini-skirts at the counter to attend to his customers. – a farmer from San Gabriel

In Ecuador, pesticides are regulated through a provision that states that highly toxics can only be purchased with a prescription from an *Ingeniero Agrónomo*. Nevertheless, the *Día a Día* investigations in Carchi concluded, "Unfortunately, this is just one more regulation that is not fulfilled in our country; even a small child could purchase these products freely."[45]

In his study on the continued use of highly toxics in Honduras, Jansen (2000: 16) found that by opposing all opposition to pesticides and through the development of complex regulations, "The industry can successfully build upon a set of internationally accepted criteria for regulation which practically exclude the possibility to ban most of these pesticides."

When confronted on the issue of weak national regulatory mechanisms, the Director of Regulatory Affairs from FMC responded, "We cannot be responsible for the flaws in a country's regulatory system." In response to his claim that carbofuran did not represent a risk for farmers, a CIP social scientist asked, "How do you calculate the risk? What do you factor in, because the calculus would change from country to country? For example, in Ecuador the socio-economic exposure conditions are very different than those in the United States, and, if you included that factor, it could lead you to a very different outcome." The FMC representative responded:

> I am very glad that you asked that question, because it helps to explain how things are done in the US. The FQPA [Food Quality Protection Act] deals with all exposures, except occupational exposure. Occupational exposure is not dealt with in the risk test. It is dealt with the 1988 Law of Re-registration. That is a very careful calculation based on all of the conditions of use in that locale: tractor, rates, formulations, crops, etc. All is determined, and determination of what is acceptable under re-regulation. The EPA is issuing a risk exposure document that takes into account all of those risk factors to avian populations, the environment, humans, etcetera.

The FMC representative conveniently limited the company's risk criteria to that not including occupational exposure, which was the central health concern associated with carbofuran use among farmers in Ecuador. Rather than address exposure, he buried the question in the details of regulatory complexities and framed the concern as a government policy matter and not the responsibility of the pesticide industry. In addition to EPA standards, when challenged over pesticide concerns, for example with regard to the

[45] *Amargo cosecha* (Bitter harvest), a 20 minute documentary produced by Adolfo Asar of the *Día a Día* Program, first aired in Ecuador in September 2001.

continued sale and distribution of highly toxics, the pro-pesticide alliance – from the national and international corporations to public servants in regulatory agencies – frequently referred to the FAO's Code of Conduct in order to demonstrate "compliance to international standards." Jansen (2000: 15) also observed this tactic underway in Central America: "In fact, the [FAO's] Code [of Conduct] legitimizes the actions of authorities and strengthens the idea that they are not responsible for misuse and accidents with pesticides."

The Ecuadorian State legitimized the "externalities" of technologies through its system of civilized controls and regulation. Nevertheless, the actual life-world of SESA, the regulatory agency, was not just composed of its civilized mechanisms of control, but also the unwritten outcomes of what it sanctioned. Through its regulatory system, Ecuador granted permission to pesticide companies to introduce toxins into the environment. A shadow effect was the contamination of the environment and the poisoning of its public. Only by means of reference to established norms and SESA sanctioning could the socio-technical regime achieve this. As a result, the shadow effects of technology regulation were not mere "externalities" of the system, but intrinsic elements of it.

In summary, it was not pesticides that degraded the environment and poisoned people. It was technology linked to the notion of effective regulatory mechanisms that formed the basis of power. In this way, the image of regulation against harmful technologies became complicit in sustaining the continuation of highly toxics.

The reflex

Interests arrived to the networks, but they were malleable and, as we saw with INIAP, vulnerable to change, which in turn produced either further entrenchment of perspective or development of new relationships, opinion and direction. When confronted by contradictions, the bureaucracy transformed causality and guilt into acquittal, thereby undermining claims to representing the public interest and opening the door for the arrival of competing forces.

Despite growing appreciation for the need to eliminate the highly toxics, SESA and eventually INIAP adopted the position that they would support the distribution and sale of these products, which resonated with the status quo of the day. Due to growing public concern over pesticides, the continued sale of highly toxics demanded a coordinated response with private industry, for example, through SUP programs and propaganda activities with grade school children and adults. Appreciation that such public-private collaborations violated the public trust led to diverse forms of questioning: television documentaries, newspaper articles, encounters during events, street protests, and boycotts. As a result, the cost of keeping the highly toxics on the market climbed.

Despite the pro-pesticide alliance's success at networking, the increasingly apparent social and environmental products of the technology at hand inevitably produced constraints that would require more radical developments: a degree of integration with the pro-health alliance via transformed versions of IPM and FFS.

Nevertheless, dissenting sub-political movements began to organize around underlying contradictions. At different moments, members of the pro-pesticide alliance perceived that a "tipping point" was being reached, leading to new activity. In reference to the May 2001 national forum of pesticide impacts in Carchi, for example, this led to a rapid mobilisation of industry representatives from Ecuador, Central America, and the United States who had organised to block proposals for eliminating the highly toxics. Faced by a threat of shifting public opinion, however, some members of the pro-pesticide alliance began to publicly portray a softer position on the highly toxics. For example, in a newspaper article, Carlos Garcia, the Andean regional head of sales for AGRIPAC, the largest distributor of pesticides in the country, publicly stated that his company was ready to replace highly toxic pesticides once they became prohibited.[46] Further, during an informal conversation with a high-level Bayer representative from Europe, I was told, "The industry has known for years that the highly toxics must go. My company already has stopped selling them back home. But our colleagues in the South are going to continue to sell them until it is either no longer profitable or politically viable to do so."[47]

Perception and perception making were at the heart of pesticide policy matters. Risks associated with pesticide exposure were essentially invisible. The immateriality of the threats meant that knowledge about them would be mediated and, as such, was dependent on interpretation. Perceptions were tied to an understanding of what constituted danger. Pesticides, not unlike nuclear technology or genetically modified organisms, produced effects that were characteristically abstract – i.e., difficult to perceive and track. As per the risk society literature (see Adam et al., 2000), this quality presents one of the great challenges to socially constituted industrial phenomenon: all interpretation is inherently a matter of perspective and hence political.

In Carchi, the politics and sub-politics of risk definition became extremely important. It was not just interest that dominated the political agenda, but claims about the legitimacy of particular forms of expertise and knowledge, for example, over putative aspects of agriculture, toxicity, products, and policy. Inter-determinacy and the inevitability of political involvement produced multiple truths and, even in the presence of seemingly objective science, there were no facts outside of the relativizing influence of interpretation based on context, position, perspective, interest, and the power to define and advocate interpretation. Knowledge was principally embodied, contextual and positional, and taking up a position, for example, on the effects of pesticides on human health or the continuation of the highly toxics, inevitably became a question of ethics.

The work of Ulrich Beck and his colleagues informs that a society that endlessly spins off technologically induced risks eventually undermines the legitimacy of its institutions, which leads to the emergence of new social forms. In other words, the "bads" of risk society produce backlash, in this case both ecological and social. The result of this phenomenon in Carchi was a public questioning of its professionals and their institutions.

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[46] "Cuatro pesticidas cuestionadas por la FAO." El Comercio. Seccion Vida Diaria, 3 May 2002

[47] Personal communication with a representative of Bayer CropScience, AgroVida Inauguration, 19 October 2001.

Beck, Giddens, and Lash (1994) describe the dis-embedding and re-embedding of society as "reflexive modernisation," a process that appeared to be underway in Carchi.

Giddens (1990: 134) believes that the awareness that the ecosystem is in collapse creates existential angst that interrupts the "ontological certainty" of normal existence. He finds that people react differently when faced with modern uncertainties, exhibiting four patterns of reaction: pragmatic acceptance, sustained optimism, cynical pessimism, and radical engagement. Giddens explains that "pragmatic acceptance" emerges as the result of an inability to cope with the knowledge that risks are beyond the bounds of human control. The more people are aware of impending harmful or even fatal events will lead them to search for security and consolation, which given the potential for economic or food insecurity, nuclear war, or disease, are hopelessly allusive. As a result, many people choose to repress their anxiety or angst by focusing on the practicalities of survival. They repress all emotion of impending doom behind a veil of hope. Faced with the threat of modern risks, some believe that with the aid of technology humankind endlessly can escape the perilous future that it crafts for itself. Provided the growing severity of environmental changes, such "sustained optimism" is built on perhaps extreme faith in rationality and science. Others cope with environmental angst through "cynical pessimism." This approach leads to contemptuous attitudes towards human nature, sincerity, or the goodwill of others. "Radical engagement" has similarities with Beck's description of sub-political movements. This involves meeting problems with optimism and activism leading to increasingly conscious activity around social change.

While certainly all four patterns were expressed in the public pesticide debate, the radical engagement of a number of sub-political movements, including the Humanists, farmer organizations and NGOs, emerged as potentially transformative forces. At the time of the close of this research, this growing group of actors disfavoured by the socio-technological developments of the day, in conjunction with coinciding effects of ecological disturbance, appeared to gain momentum. The fact that certain industry representatives began to publicly acknowledge the inevitability of a shift with regard to the sale and distribution of highly toxics suggested that proposals for change had become less radical than previously.

Conclusions

Researchers working in Central America stated, "Documentation of pesticide poisonings during several decades never induced any decision to ban or restrict a pesticide" (Wesseling et al., 2005: S697). Similarly, after presenting their research at multiple public forums on pesticide concerns, the CIP-led group of collaborators discovered that the issue at hand was not a lack of high quality information or alternatives. The pesticide socio-technology trajectory depended on far less rational and far more social and political factors.

We encountered a cultural power-matrix surrounding the use of pesticide technology, which organized to shape public opinion and policy and ultimately assure an open market for harmful technology. An alliance of actors, often led by private industry, operated to entrench present regimes of thinking, organizing, and doing, even at the cost of the health of the majority of rural people in Carchi.

After people learned about the evidence of pesticide health effects, the social "playing field" temporarily levelled, and the pro-pesticide alliance forged new reasons for complementary action. The continual framing and reframing of Safe Use of Pesticides and the translation of prestigious symbols, such as FFS and IPM, as well as a relatively small investment of funds built and rebuilt a safe, attractive platform for collaboration over an increasingly controversial theme.

Highly dynamic networks of competing and colluding actors defined and re-defined the public agenda. Interests arrived to networks, but they were malleable and even the most entrenched stances (e.g., those belonging to the national research institute, INIAP) and seemingly strong positions (of the pesticide industry) were vulnerable to change and indeed, changed. In addition to the national regulatory agency, SESA, which by the late 1990s had become a strong pro-pesticide ally, CropLife managed to enlist INIAP and the Ministry of Education onto its increasingly problematic agenda of sustaining harmful technology. In the process, the industry won degrees of legitimacy, and it gained public sanction for the policy of SUP as the appropriate public response to the latest wave of concern over pesticide technology.

The trajectory of pesticides depended on the success of scientists and *técnicos* as entrepreneurs – indiscriminately mixing economic, political, natural, and cultural claims to truth. In addition to "black boxing," continual enrolment was a central activity. This involved network-building through processes of translation, leading to new relationships around relatively unproblematic sets of interests. Success depended on the capacity of networks to grow, strategically influence perspective and positions, and change.

Organizations and institutions operated as boundary objects (i.e. inter-institutional spaces of encounter and negotiation), where perspectives were both consolidated and transformed. Over time, networks evolved into coherent, well-defined regimes with visible faces and organizations, exercising authority and exerting influence. At any given time, a particular alliance appeared as a mature structure, consolidated around a particular set of positions. Upon becoming overly consolidated and rigid in administration, content, or activity, however, networks became vulnerable to competing interests.

The uncontrollable and unwanted products of pesticides exposed contradictions between the public discourse of the influential and their policy outcomes, leading to public questioning of authority. Sub-political actors, especially social movements and NGOs, organized around ideals of agroecology, arose as transformative forces. Ironically, it appeared that the entrenchment of institutional claims to knowledge and technology and the deepening and broadening of pesticide effects on society and the environment provided the pre-conditions for demise and change.

Chapter 8

Learning from Carchi: The Production of Decline

Introduction

This dissertation has explored ecosystem decline and associated human health problems in Carchi, summarised as the *pathology* of modern agriculture. Tendencies were not mere externalities or accidents but dangers that increasingly became the expected result of agriculture. The State was the sanctioning agent. Dangers did not just emerge from the environmental world, but rather they had become an inner product of society. Beck (2000: 221) argues, "The loss of boundaries between these realms [nature and culture] is not only brought about by the industrialization of nature and culture but also by the hazards that endanger humans, animals, and plants alike." A central theme of modern society in Carchi had become what Beck described as a "manufacture of uncertainty" from within.

In this dissertation I iteratively pursued a series of questions as a means of unveiling central features behind the pathology of modern agriculture. This final chapter summarizes the findings on the major research questions that I posed at the onset:

1. What historical events preceded agricultural decline in Carchi?
2. What social and institutional factors prevented the uptake of recommended "best practice," in the form of cross-disciplinary research (i.e., the Eco*Salud* project) and knowledge-based, people-centred interventions (Farmer Field Schools)?
3. How did institutional actors respond to policy proposals for the elimination of highly toxic pesticides?

Thereafter, I move on to address a final pair of questions as an extrapolation of my experience:

4. What are the institutional features behind the production and continuity of agricultural decline in Carchi?
5. What lessons does Carchi hold for more sustainable agriculture?

Findings

Chapter 2 summarized a decade of multidisciplinary research in Carchi that raised concerns over the sustainability of agriculture as a result of its effects on the environment and especially the health of rural people. Between 1990 and 2001, a number of national and international organizations worked with communities in Carchi on projects to assess the role and effects of modern agriculture in potato production and to identify opportunities for reversing its harmful consequences. The research-action initiatives contributed to numerous academic publications and graduate-level theses that were summarized in two compendia: Crissman et al. (1998) and Yanggen et al. (2003a).

Provided its natural endowments, generally educated population, infrastructure and market access to both Colombia and Ecuador, Carchi is potentially one of the most productive agricultural regions in the Andes. Potato farming there has evolved to become a major source of livelihoods, dominating the modern landscape. On less than a quarter of the country's area dedicated to the crop, in the 1990s Carchi came to produce about 40 percent of the yearly national potato harvest. Nevertheless, today's farming does not just produce a lot of potatoes; it also produces ecological disruptions.

The researchers found that the use of modern technologies generated worrisome environmental, productivity and human health consequences. Tractors and total tillage were the leading cause of soil erosion, displacing some 80 t/ha each cropping season. Each year farmers spent more on agrochemical inputs and received less for their crop, leading them to lose money on well over half of their plantings. Meanwhile, two-thirds of the rural population – including men, women and children – suffered measurable neurological damage due to exposure to highly toxic pesticides. Economic studies identified a relationship between pesticide exposure and low productivity. After automobile accidents, suicide by pesticide ingestion was the second leading cause of death in the province. Further, as per an elderly man from La Libertad, "Our farms are dying." The forests were disappearing or already gone. Farmers no longer controlled their varieties and farms had lost their biodiversity. Decades of mechanical tillage and heavy agrochemical use had disrupted soil ecosystems. It had become increasingly difficult for farmers to financially survive. Something had gone wrong with agriculture.

1. What historical events preceded agricultural decline in Carchi?

After summarising a lengthy list of data as evidence of a "Third World crisis," Arturo Escobar (1995: 213) concluded, "Statistics tell stories. They are techno-representations endowed with complex political and cultural histories." While highly informative on the present state of the ecosystem and its effects on human well-being, the wealth of biological, economic, and health research did not, however, explain how the present-day situation came to be. Devoid of historical insight, we are blind to the roots behind the modern-day situation, greatly limiting our ability to reorganize around more sustainable futures.

Chapters 3 and 4 aimed to summarise the major events leading up to present-day agriculture in Carchi. I researched historical records and literature and interviewed key informants on the general history of the province. *Carchense* farming evolved to exploit niches distributed across ecological floors, a practice called "micro-verticality," which permitted slow but relatively stable development in the highland Andes. Since that time, increasingly distant and exogenous influences have come to drive rural developments. The brief arrival in Carchi of the Incas followed by the Spanish Conquest and the feudal hacienda system radically changed Andean agriculture. By the decline of the hacienda system in the mid-twentieth century, traditional community structures had undergone dramatic transformation, and the system of vertical farming was replaced by extensive, horizontally distributed agriculture, which in mountain environments proved vulnerable to the elements as well as pest and disease epidemics.

In the second half of the twentieth century, processes of colonization and land reform ended the hacienda era in Carchi and provided smallholder farmers title to land and high expectations for the future. Generally, the land areas of the fertile valley floor remained in the hands of *hacendados*, though their landholdings were considerably smaller than previously. Meanwhile, new classes of farmers became relegated to steeper and lesser fertile hillside land. Aggressive "agricultural modernisation," built on the promises of market integration and industrial-era technologies as means of progress, followed. Not unlike the Incan and Spanish arrivals, actors and institutions of the post-hacienda period commonly were socially distant from ruralities. A deepening of agricultural development away from localities and towards distant markets and externally based technologies became a central feature of the rural landscape.

Modern-day Carchi is a clear example of the spread of industrial agriculture technologies in the Americas during the "green revolution" that began in the late 1950s. A tradition of planting in partnership between the landowner and landless labourers provided unusual access to financial resources and credit conditions for the rural population. Furthermore, as a result of new revenues from the oil boom of the 1970s, the Ecuadorian government invested in the province's transportation and communication infrastructure. Provided these conditions and market-oriented policies, an emerging agricultural products industry was quick to capitalize on the availability of a new and growing population of smallholder producers. Many of the owners and salespeople of the agrochemical industries were previous hacienda owners and their descendants. As such, rural development in Carchi often represented a transfer in roles, rather than a change in social position.

Smallholder potato production based on monocropping and energy-intensive technologies, specifically mechanized tillage, synthetic fertilizers and pesticides, quickly transformed farming. Production, both by area and by labour input, intensified dramatically. A prominent study by Barsky (1984) showed that between 1954 and 1974, production increased by about 40 percent and worker productivity by 33 percent. Production by area in the province continued to increase into the 1990s, from about 12 t/ha in 1974 to about 21 t/ha in the early 1990s – three times the national average (Crissman et al., 1998). Nevertheless, this progress did not occur without costs.

To further place modern developments in context, I consulted diverse age groups from four rural villages on the critical periods of their history. Different than other regions of the highland Andes, most generally did not identify strongly with indigenous populations, instead feeling that their cultural history largely began with the haciendas. Collectively, they agreed upon four major periods of modern change: the hacienda, land reform, technification/market integration, and dollarisation. The characteristics of these periods were explored during home visits and interactive workshops, at community as well as inter-community levels.

This research found that market integration and "technification" led to potato intensification, mechanized tillage, the introduction and increased reliance of agrichemicals, and a shortening of fallow periods. Over time, market forces led to greatly reduced on-farm biodiversity. By the early 1990s, a very fragile, total tillage, external input-intensive monoculture of a single, dominant variety, Superchola, occupied much of the landscape. These changes destabilised biological systems and, due to a compensating and then aggravating intervention of agrochemicals, spurring soil degradation and a public health epidemic. By the mid-1990s, this situation had become endemic – an integral part of rural life.

Most recently, production by area and productivity levelled, followed by a decline. Real prices for inputs grew at an accelerated rate and commercial prices for potato showed rising rates of variability. Increasingly, farmers began to lose money on their crops, with financial failures on about 43 percent of plantings during the 1991-1992 season (Crissman et al., 1998) to more than 60 percent in 2004-2005 (Chapter 4). At the same time, farmers and their families suffered harmful health effects from acute and chronic exposure to chemicals (Cole et al., 1997a and b; Cole et al., 2002) that adversely impacted their economies (Antle et al, 1994; Antle et al., 2003). In summary, agricultural modernisation undermined ecosystems and eventually worked against the health and economic well-being of rural people.

The social effects of modern agriculture appeared equally dramatic. Some thirty-five years after market integration and technification, farmers found themselves in a crisis they called "dollarisation," which led to increasingly volatile compensation for commodities, losses, and debt. As a result, the turn of the twentieth century in resource-abundant Carchi was marked by the growth of two sectors: the landless labourer and the urban migrant.

Further analysis with communities showed that patterns of development were at once conserving and dynamic. Change was not abrupt but rooted in combinations of continuities and discontinuities as a result of structural coupling to co-evolving social and biophysical conditions. Participants described a "memory" effect: past legacies that carried on into the future. As a result, diverse aspects of the hacienda period, for example, remained until today, such as the surviving legacy of the *patrones* who continued to hold prestigious positions in Ecuadorian society through both old and new social forms: continued land ownership and exploitative labour arrangements, political position in local and national government, the sale of agrochemicals, or through the banks and credit systems. Nevertheless, some farmers felt that the present social environment provided greater "freedom" or room for manoeuvrability than previously, and as a result, they were able to exert greater influence over their futures than under the haciendas. Meanwhile, others emphasized that in modern society their families and communities effectively had been "re-enslaved."

Undesirable products of modern agriculture led to social and ecological outcomes that in turn sparked new directions of change. Examples of perceived external environmental and social forces of change were: late blight (caused by an exotic pathogen, that most now considered endemic), the Guatemalan tuber moth (an exotic insect pest that arrived in

1996) and, most recently, new weather events, in particular, longer dry spells and unpredictable rainfall patterns. Externally sourced forces of change were: increasing price fluctuations in for potato, the loss of the Sucre, increases in agrochemical prices, and increasing political instability (i.e., seven Presidents in less than a decade and a greater number of agriculture ministers). Examples of perceived internal forces of change were: land reform, the creation of communities, the "settling" of the forest, soil degradation, "rebellious youth," and a "loss of control" over families and community.

From a biophysical point of view, modern technology had enabled farmers to structurally break with nature, leading to subsequent environmental backlash. From a socio-cultural perspective, people and their communities were increasingly fragmented (both individually/psycho-socially (a sense of detachment) and collectively (a tendency towards valuing the market over neighbour, neighbourhood, and community). These two phenomena interacted to produce socio-biological decline characterized by increasing environmental and social uncertainties. Farmers expressed a growing sense of frustration as a result of recent experience. One participant seemed to represent many when he declared, "We have done everything the *ingenieros* have told us to do, and look where we are.... We are going broke." In recent time, a growing number of people had begun to abandon agriculture and migrate to urban centres in search of work. An undetermined number of youth in each of the communities where we worked had joined armed guerrilla forces in nearby Colombia.

*2. What social and institutional factors prevented the uptake of recommended "best practice," in the form of cross-disciplinary research (i.e., the Eco*Salud *project) and knowledge-based, people-centred interventions (Farmer Field Schools)?*

Chapters 5 and 6 were retrospectives on the three-year Eco*Salud* project and the introduction of Farmer Field School methodology in Carchi. Under the demands of project implementation, professionals from both research and development camps involved in Eco*Salud* were forced to confront differences and negotiate interests. While this interaction sometimes led to unsatisfactory results for some, it also contributed to new skills and understanding of previously conflicting perspectives. We found cross-disciplinary research particularly challenging at the field level, where contradictions were most stark. Working cultures for staff members (e.g., agricultural extension, participatory research, feminist social change, and health services) were built on different sets of assumptions, methods of resolving conflicts, planning, and perceived roles in development. The mediation of differences often carried high transaction costs.

Through sometimes-difficult processes of accommodation, the staff gained insight into divergent perspectives. With new understanding, participants learned to work in complementary ways that advanced project purposes, for example over more integrated use of research data and interactive, "participatory" methodologies capable of addressing the priorities of both scientists and development practitioners. When confronted by external obstacles, for example over pesticide policy matters, staff joined force and collaborated to foster a common agenda, framed around the elimination of highly toxic pesticides.

Despite much cross-disciplinary learning and practice, we could not hide from the fact that the vast majority of rural people in Carchi continued to be chronically exposed to harmful pesticides, and as a result, they suffered serious neurological damage that affected farm productivity and family well-being. The research generated a wealth of high quality information on the dramatic health problems associated with pesticides as well as scientifically informed and replicable alternatives. We proactively communicated this experience to policy makers and the public. Nevertheless, very little was achieved in improving the situation in rural communities.

This experience exposed fundamental conflicts of paradigms and process that circumscribe institutional capabilities of addressing complex ecosystem health concerns. Specifically, this includes the priority of continual social and environmental coupling. Enhancing the accountability of science and development to localities requires new ways of thinking, organizing, and doing that arguably lie outside of current institutional constraints.

To explore the experienced tensions between our staff and professionals in general, I drew on a taxonomy of scientific paradigms based on the mapping of ontological and epistemological extremes (Figure 5.2). My colleagues and I found that the mediation of differences became a priority. In retrospect, a common concern over the public health crisis – especially public confrontations with competing actors over pesticides – generated reasons for wanting to collaborate between previously competing perspectives. By the end of Eco*Salud*, we gained appreciation for the role of generalists, capable of bridging disparate positions and perspectives.

Reflective analysis over five years of experience with Farmer Field Schools provided insights into the potentials and limitations of methodology-based interventions. FFS provoked new thinking and creative practice at the farm level. While showing much potential early on, the methodology faced limitations at leveraging institutional change. A series of critical studies found that FFS practitioners were systematically “cutting corners” and pulling the methodology towards more expert-centred designs. My colleagues and I found that FFS scaled-up in name, but not in meaning. This tendency had become a dominant phenomenon in Carchi, as elsewhere, and thus, it arguably was no mere oversight or accident, but the outcome of a cultural knowledge battle – the methodology was at conflict with dominant research and development paradigms that informed institutional designs. Apparently, conflicting purposes led actors and their organisations to systematically erode Field Schools to the point where much of the methodology’s epistemological identity fell into question.

Based on the experience with Eco*Salud* and FFS, I reached the conclusion that the major obstacles to change were not due to mere *lacks* of information, knowledge, technology, or market alternatives, as farmers, experts, and policy makers commonly argue. Instead, more subtle social forces were at play, requiring further attention for sustainable development.

3. How did institutional actors respond to policy proposals for the elimination of highly toxic pesticides?

Experiences from the Eco*Salud* project and FFS methodology exposed contradictions and raised doubts about the existing order of science and development practice at levels of farming, science, and government. Chapter 7 explored the social and political processes of keeping highly toxic pesticides on the market. I encountered a cultural power-matrix surrounding the use of pesticides that informed public opinion and policy and ultimately enabled a continuation of self-destructive agriculture. It operated to entrench present regimes of thinking, organizing, and doing, even knowingly at the cost of the health of the majority of rural people in Carchi.

While powerful actors were effective at translation of prestigious symbols and enrolling public actors to win legitimacy and public sanction, increasingly obvious contradictions between public discourse and local experience fomented a reflexivity that fed back on existing order. The arrival of sub-political forms, particularly farmer and social movements, sometimes supported by NGOs, rose to become transformative forces. At the close of this research, the proposals of these groups were yet to take social hold, but it was evident that local social movements were having a growing influence on communities, government, and industry. Whether or not a tipping point had been reached remained to be seen, but aggressive responses by the powerful, especially the national pesticide industry, suggested that the existing order had been shaken.

The trajectory of socio-technical change around pesticides depended on the success of scientists and *técnicos* as entrepreneurs capable of indiscriminately mixing economic, political, natural, and cultural claims on truth. In addition to "black boxing" or myth creation, continual enrolment was a central activity. This involved network building through processes of translation of interests leading to relationships around relatively unproblematised sets of interests. Success depended on the capacity of networks to strategically grow and shape perspective. This activity, however, was continuously vulnerable to changing public perceptions, which in part were influenced by the sub-products of technology – socio-environmental uncertainties and their spin-offs. In the case of pesticides, these sub-products undermined existing order.

Exploration of the *structuration* of the pesticide technology regime found that institutions behaved as boundary objects, where perspectives were both consolidated and transformed. Over time, certain networks matured into coherent, better-defined regimes with visible faces that exercised authority and exerted influence. At any given time, a particular alliance of actors appeared as a well organized structure consolidated around collections of positions and interests. Upon becoming overly consolidated and rigid in administration, content, or activity, however, networks became vulnerable to emerging interests, especially those of sub-political actors that laid outside well-established power structures. Ironically, it appeared that the entrenchment of institutional claims to knowledge and technology and the deepening and broadening of technological effects on society and the environment provided the preconditions for the demise of existing order and change.

Looking deeper

4. What are the institutional features behind the production and continuity of agricultural decline in Carchi?

<u>Carchi as a theatre of risk</u>

The dangers of agriculture technologies in Carchi became so far-reaching and generalized that it was no longer possible to blame any particular individual. The guilty party had become the "System."

In their quest for a social theory that encompassed reflexive modernisation (i.e., "… the inescapable self-confrontation that accompanies the contemporary industrial way of life."), Adam, Beck and Van Loon (2000: 2) summarized five central features of modern risk:

1. Risk perception is socially constructed.
2. Risk is invisible and subject to interpretation.
3. Risk crosses disciplinary boundaries and demands bridging between arbitrary lines dividing knowledge and practice.
4. Conceptualization and management of risk needs to progress from notions of calculation (binary logic) to mediation.
5. Society that endlessly spins off technologically induced risks eventually undermines the legitimacy of its institutions, thereby producing new social forms.

I observed these five factors actively at play in Carchi.

The text of Adam, Beck and Van Loon (2000) points out that, distinct from environmental uncertainties, people manufacture risks through the application of technologies as well as the very making of sense by a society that defines and prioritizes a particular danger, harm, or threat. Risks include the empirical world of social fact as well as the less tangible world of social construction. That is so because technologically constituted hazards include a virtual domain of latency, invisibility, and contingency. Furthermore, socially constructed risks are lived as potential and not actual harming. As Van Loon (2000) argues, perhaps more important than the social construction of risk is the "becoming of risk," – i.e., how people become increasingly aware of and concerned about previously damaging but unperceived threats to their well-being.

This thesis examined how risks associated with modern agriculture technology were manufactured through the construction of agricultural practice that involved farmers, but also broader society. The problem was so far-reaching and generalised that it was no longer possible to place the blame on an individual, such as a farmer or pesticide salesperson. At first, the abstractions of pesticide poisonings and environmental degradation made their effects "invisible" and difficult to tract and perceive. This factor may have played a role in the establishment of pest and soil management technology. Nevertheless, once research made explicit those effects, for example through quantitative measurement of neurological damages or soil losses, a powerful class of brokers that had grown around the causal technology organised to block public understanding of that information. These actors – farmers, chemists, agriculture researchers, extension agents, salespeople, and regulatory officials – made their living off the proliferation of the technology. A cynical researcher once told me that "environmentalists" (i.e., myself) made their living off questioning existing technology. Actors on all sides manoeuvred, strategised, collaborated, and colluded to influence public opinion around particular agenda and purposes. In light of the aforementioned features of modern risk, this brings me to a conclusion around the Carchi experience: *Social constructions – not the "facts" of our biophysical or economic research – primarily configured pesticide risk perceptions.*

The immateriality of the threats inherent in a risk society means that knowledge about it is mediated and thus dependent on interpretation. Perceptions of risks were tied to understanding what constituted danger. Pesticides, not unlike nuclear technology or genetically modified organisms, produced effects that were characteristically abstract – i.e., difficult to perceive and tract. As Beck (1992) argues throughout his thesis, this quality presents one of the great challenges to socially constituted industrial phenomenon: interpretation inherently is a matter of perspective and hence political. As described in Chapter 7, the politics and sub-politics of risk definition with regard to pesticides became extremely important.

It was not just interest that dominated the political agenda, but claims about the legitimacy of particular forms of expertise and knowledge. Inter-determinacy and the inevitability of political involvement produced multiple truths. Even in the presence of seemingly objective science, no facts lay outside of the relativising influence of interpretation based on context, position, perspective, interest, and the power to define and advocate interpretation. Far from being neutral, knowledge was situated. The experience in Carchi shows how knowledge is principally embodied, contextual and positional. Taking up a position, as we saw for example with regard to the effects of pesticides on human health, ultimately became a question of ethics. In conclusion: *The risks associated with pesticides were essentially invisible and subject to interpretation. As a result, it was not rationality but the successful entrepreneurship of actors that informed public perception and determined policy outcomes.*

Critical of disciplinary boundaries and the attendant dualistic choices between culture and nature, local and global, public and private, Beck (1992) argues that risk demands new thinking in cross-disciplinary areas that previously have been out of bounds for particular scientific disciplines. Indeed, the risks associated with farming practice in Carchi crossed traditional knowledge domains and demanded interaction among different schools of thought and practice. The study on the activity of the pesticide power matrix revealed how broader sectors of society became involved, for example from different sectors of local and national government, private industry, the media, as well as the general public. The reach of pesticides was far. In conclusion: *The risks associated with modern agriculture practice crossed disciplinary boundaries and demanded bridging between arbitrary lines dividing knowledge and practice; policy and action; internalities and externalities. Expert-oriented institutions were incapable of mediating these differences, and, in fact, they played a central role in creating and representing the myths and conceptual blindfolds that prevented people from finding alternatives.*

The experience in Carchi suggests that societies need to go beyond conceptions of risk and technology as social constructs and grasp instead how specific technologies influence futures and in what way associated risks are experienced, perceived, defined, mediated, legitimized, or ignored. Created for specific functions and without cognizance of the networked interconnectivity of life, Adam (1998) explains that technological products enter the living world as "foreign bodies." Once inserted into the ecology of life, they begin to interact with their networked environments, and from that point onwards, scientists and engineers inescapably lose control over the effects of their creations. The research showed how innovative, disembedded technology with impacts that were temporally and spatially unbounded rendered traditional assumptions about planning and managing the future inappropriate. Science was incapable of predicting a priori the effects of modern technology on rural life in Carchi, and that capacity greatly decreased after those technologies were released into local culture and the environment. Effectively, technology had taken on a life of its own. In conclusion: *The directions taken by the modern agriculture technology in Carchi were essentially unpredictable and their effects unknowable.*

In this thesis, I presented how a multitude of public stakeholders, including farmers, pesticide industry, local government, regulatory agencies, and purchasers, as well as the general public, played roles in diverse forms of managing risks – from suffering harmful consequences, organising around emerging opportunities generated by the consequences of technology, to shifting the investment of material and social resources. In practice, risk management demanded multi-actor social interaction and learning, demanding continual mediation. It also required advocacy, particularly on behalf of less favoured members of society, such as marginalized rural people, so that they could gain voice in mutually acceptable outcomes. In conclusion: *The conceptualization and management of risk needed to progress from notions of calculation and prediction to mediation.*

According to Beck (2001: 275), "…dangers are being produced by the legal system, externalized by economies, individualized by the legal system, legitimized by the natural sciences and made to appear harmless by politics." When people become aware of changing context, they act. In agriculture, the environment likewise "responds." In Carchi, we observed that the "bads" of risk society led to backlash, in this case clearly both ecological and social. The result was a public questioning of its professionals, authorities, and institutions. Beck, Giddens, and Lash (1994) describe the dis-embedding and re-embedding of society as "reflexive modernisation," a process that appeared to be underway in Carchi and leading to new social forms. In conclusion: *Society that endlessly spins off technologically induced risks eventually undermines the legitimacy of its institutions, which catalyzes reorganizations.* The effect in Carchi, however, appeared to go beyond a mere reorganization of society to a more fundamental socio-environmental breakdown and system decline.

5. What lessons does Carchi hold for more sustainable agriculture?

> If disease is an expression of individual life under unfavourable circumstances, then epidemics must be indicative of mass disturbances. – Rudolf Virchow

Generally acknowledged as the father of modern pathology, in the second half of the nineteenth century, Rudolf Virchow authored more than one thousand books and papers on diverse aspects of cell pathology as well as the anthropology of medicine and its politics. He drew heavily on metaphor to describe disease not as an individual event but a holistic phenomenon. Studying what he called "typhus," in 1847 Virchow quickly figured out the epidemiology of the disease. Nevertheless, he argued that the solution did not lie in managing the pathogen (a bacterium) or the vector (fleas), but rather addressing the underlying social causes: misgovernment and disparity. As such, his treatment plan became "full and unlimited democracy." If Virchow were in Carchi today, he would argue for looking beyond the modern-day symptoms of agricultural decline – the "exhausted" soil, the pests, or even the low market prices – to the underlying social roots of the situation.

The reflex

Beck (2000) identified three correcting reflexes common to risk societies: 1) society becomes aware that it is a risk to itself, 2) there is an impulse towards cooperative international institutions, and 3) political boundaries erode, leading to constellations of sub-political forces.

The people of Carchi increasingly became aware of a universal pathology – technology-induced ecosystem decline – that diversely undermined its environment, economy, and social systems. The natural system had evolved to become less diverse and more vulnerable to change in ways that triggered unexpected and undesired chains of event. Commoditisation of rural life had distanced people from their communities and their environment, leading to unsustainable ways of living. Most recently, dollarisation led to increases in the prices of technologies, which in turn led to heightened production costs, labour cost-cutting and unemployment, and migration, creating scarcity of workers and feedback in the form of increased labour costs, and so on. At the same time, agroecosystems had become less "able" to buffer events, such as pest outbreaks or weather fluctuations. Meanwhile, local companies had grown dependent on product sales, and they increasingly sought to inform public policy in ways that would sustain those sales. As the public became aware of the contradictions and their predicament, it lost faith in government.

The rules of responsibility – causality and guilt – broke down in Carchi. The routines of decision-making, regulation, and production generated ecosystem collapse as well as legitimized and sanctioned it. As Beck (2001: 271) explains, "… it is not rule-breaking but the rules themselves which 'normalise' the death of species, rivers, or lakes." He described the self-destructive feature of modern societies as "organised irresponsibility." The question follows: how do modern institutions deal with a self-generated ecosystem crisis? The answer from Chapter 7, on the dynamics of pesticide politics, was clear and resounding: they do not. Transformative change must come from outside the System.

Beck (2001: 272) explains, "[In a risk society] the legal order no longer guarantees social peace, because it generalizes and legitimizes the threats to life." While CropLife, SESA, INIAP, the Ministry of Agriculture, the Ministry of Public Health, the FAO, and the WHO argued over meanings of safe levels of exposure, the people of Carchi continued to systematically suffer serious degrees of neurological damage. Government officials and professionals could continue to obey the rules, but in the eyes of the public, authorities became "criminals" and "murderers."

Nevertheless, there was some movement at the level of government. Recently, the municipalities of Carchi had established new "healthy eating" programs and different forms of environmental protection units, supporting organic food markets, reforestation, and protection of watersheds. In addition, two municipalities in Carchi approved ordinances calling for the elimination of highly toxic pesticides. While INIAP's field office continued to collaborate with CropLife, the institute's National Potato Program began to promote "alternative technologies," such as conservation tillage, native cultivars, and "clean" and "organic" production. The 2008 constitution included a promising "food sovereignty" law that, at the time of this writing, was undergoing vigorous debate, involving a number of actors from northern Ecuador and the agroecology movement. While Ecuador may have become increasingly aware that it was a risk to itself, it was unlikely that those institutions structurally tied to the past would lead society to a more sustainable future. The underlying organised irresponsibility – in particular, externally based knowledge and technology as well as the strategic distancing of markets – remained.

While undermining the sale of highly toxics was tantamount to economic suicide for national corporations and, thereby, an unlikely political prospect from within Ecuador, it was possible for individuals at certain international organisations, such as the International Potato Center, World Bank, and FAO, to begin to question their sale and distribution. In December 2006, Shivaji Pandey, the FAO's Director of Plant Production and Protection, in a bold move, called for the global elimination of highly toxic pesticides.[1] In a public statement, he said, "There is no way to ensure the chemicals involved would be used within acceptable margins of risk in developing countries." He added, "Use of the [highly toxic] pesticides has been prohibited or severely restricted in OECD countries and FAO would like to see them banned at the earliest date in developing countries, where farm workers often lack adequate personal protection." A handful of developing countries, including China, Thailand and Viet Nam, had made plans for prohibiting the use of Class I pesticides. Mr. Pandey called upon other companies and governments to follow these examples and expedite the withdrawal of WHO Class I pesticides from their markets. Nevertheless, the FAO, at the organisational level, showed no movement in supporting a Pandey's call for a global ban on the highly toxics. Despite courageous leadership from within, large organizations were slow to change.

Meanwhile, a growing number of actors in Carchi emerged to challenge the existing order. These included charismatic individuals, such as farmer leaders and progressive professionals, as well as organizations, such as NGOs (EcoPar, Randi-Randi, Acción Ecológica), networks (the Carchi Consortium, MACRENA, the Pesticide Action Network), and less formally structured social movements (the Humanists). While the

[1] FAO encourages early withdrawal of highly toxic pesticides: Assurances given by Danish company. FAO Newsroom. 20 December 2006. (viewed at: www.fao.org/newsroom/en/news/2006/1000471/index.html)

NGOs were more vulnerable to the whims of donors and thematic- and time-bound projects, local leaders, networks, and movements demonstrated greater flexibility in questioning the established order as well as in sustaining positions over longer periods of time. Lying outside the bounds of the nation-state or industry, these actors represented what Beck described as a "self-organization of politics" and often generated agenda that went against officialised government programmes. In fact, the identities of these actors – the sub-political – were often tied to their ability to publicly challenge government, regulatory agencies, research institutions, and international corporations.

Sub-political actors often lay outside the protection of law, making them vulnerable to public sanctions. Industry representatives, government officials, and the media were quick to label sub-political actors "controversial" and "radical." For example, during protests over the Free Trade Agreement, which included negotiations over agrochemical imports, the Ministry of Government decided to target NGOs as organizations that "manipulated the Indians," thereby encouraging further strikes and protests. As matters intensified, the government threatened to revoke diplomatic visas of international staff and change the tax-free status of NGOs.[2] In March 2006, several foreigners attending the protests were arrested and deported from the country. It became clear that the certain government agencies (as well as the US State Department) had grown intolerant of dissent to their policies. In 2008, the Correa administration continued to display an intolerance towards dissension, for example in response to the sharp criticisms it received over its rural development program based on the building of agrochemical plants, introduction of genetically modified crops, and the re-orientation of production around biofuels.[3]

Beck (2001) finds that the global consequences of risk society – i.e., the systematic violation of basic rights – have led to a weakening of societies, making possible the emergence of not just local but also global sub-politics. In making public the concerns in Carchi, my colleagues and I made contact with networks of colleagues confronting similar circumstances elsewhere in Ecuador and the Andes as well as Central America, Africa, and Asia. Individuals who had a long history of addressing such concerns at the grassroots level were part of growing international networks and organizations. We quickly identified common agenda, exchanged information, and coordinated activity by e-mail and telephone. We wrote publications together and collaborated on efforts to reach the popular media. We strove to influence the policies of bilateral donors and international organizations and movements, such as CIP, FAO, and the World Bank as well as the regional agenda of the Humanist Movement in Europe and Latin America. While our strategies sometimes focused on countries, they also targeted farmers, consumers, and the media. Beyond being part of local sub-politics, we became part of what Beck (2001: 276) describes as "the new constellation of global sub-politics." Marginalised and estranged by

[2] In 2005, the network of international NGOs operating in Ecuador hired a team of lawyers to counter the government's proposed revisions to established legal contracts with international agencies. Concerns were outlined in the document, "Legal regime for NGOs in Ecuador: analysis of the proposed legal agreement," VGYLEX Abogados, 6 June 2006, 4 pp.

[3] The CEA, RAPAL-Ecuador, and the Agroecology Collective regularly voiced concerns over the Correa administration's agriculture and environmental policies during the debates over the "Food Sovereignty" law. For an example, see: "AsíCea" Boletín Electrónico, Coordinadora Ecuadoriana de Agroecología. Noviembre, 2008 (available at: www.ceaecuador.org)

country-level bureaucracy, the emergence of global sub-politics appeared to represent a growing liberalizing and emancipating force.

The question of alternatives

By this point, my colleagues in rural development would be impatiently shifting in their seats, waiting for the opportunity to ask: This criticism is well and good, but what is the alternative? By now, the answer should be clear: there is no single alternative for all places and situations. As Escobar (1995: 222) makes clear, "To think about alternatives in the manner of sustainable development, for instance, is to remain within the same model of thought that produced Development and kept it in place." The *solution* is to not fall into the trap of providing abstract or macro-level answers. This does not mean that there is no role for expert knowledge and technology or researchers, development practitioners, and policy makers. The alternative emerges from understanding the role of the outsider in providing the *non*-alternative – i.e., to strategically not feed the development process with answers. The answer lies in questions.

In this thesis, I have argued that agricultural development in Carchi worked against the viability of social and environmental ecologies, and in so doing, it undermined "life." Based on the ideas of Westley et al. (2002) and Stepp et al. (2003), Box 8.1 summarises examples that challenge common assumptions on humans as "ecological animals." It must be acknowledged that humans may embody unique social and cultural qualities that ultimately undermine their ability to live sustainably. Our nature, if indeed a nature exists, may include self-destruction. If we were to co-exist among ourselves and with the environment, however, how must we learn to organize?

Despite curative claims, today's institutions are structurally tied to the same logic and value systems that induce and sustain the problematic qualities of modernity – i.e., organised irresponsibility. In fact, rather than look to experts for a way out of the modern predicament of ecosystem decline, a growing body of literature has come to acknowledge the place of experts and their institutions at the centre of the global crisis (for example, Röling, 2002). Holling (2000) highlights a number of problems underling expert logic:

- Preoccupation with the norm – a focus on central tendencies rather than probability distributions and extreme events
- Existence of isolation – belief that different sectors do not interact or, if they do, those interactions are not important for affecting change
- Power of rationality – expectation that change will be incremental and linear
- Human as supernatural – an objective of some optimal state of the system, usually human conceived and managed, that will deliver sustainable development

As a result of such misconceptions, in its attempt to address the ecosystem crisis, expert-based science and development inevitably contribute to socio-environmental decline. The first task for more sustainable futures becomes reorganization around logic more consistent with the requirements of sustainability.

Box 8.1 Evidence from Carchi that humans may not be ecological creatures (based on Westley et al., 2002 and Stepp et al., 2003)

• Belief systems – Religious beliefs, for example, can influence what people think and do, despite the feedback that individuals may receive from the biological world. In Carchi, farmers applied pesticides to their potatoes based on deep-seated beliefs in the calendar or lunar cycle, regardless of weather conditions or visual feedback from fields.
• Externalised human cognition – Humans perceive and provide meaning to objects and actions based on interpretive experience with the outside world. Farmers refused to plant on a particular date because of a negative past experience, despite seemingly favourable environmental conditions for plant growth.
• Techno-substitution – Increasingly, people impose techno-structure on bio-structure. Since land reform, Ecuadorian society has promoted market-oriented agricultural intensification, which can produce ecological disruptions and place a thermodynamic strain on the ecosystem (Pimentel el al., 1992).
• Historical and political determinism – Social and political histories can determine human ecosystems. The institutional consolidation of the pesticide industry came to influence modern government in ways that prioritised short-term food production interests over longer-term human health and environmental interests.
• Lock-in – Once embedded in a culture or belief system, a technology can be reproduced and proliferate even beyond its immediate usefulness. The highly toxic pesticides carbofuran and methamidophos became part of farming culture in Carchi. Ability to withstand neurotoxins defined aspects of masculinity, a clear example of self-destructive behaviour from a human health perspective. The popularity of these products financed a powerful network of actors that organised to proliferate their use, even after the harmful effects of these products became explicit and alternatives became known or knowable.
• Belief in the supernatural – A powerful belief system is built on the aspiration to transcend the natural world through supernatural experiences. A network of actors in Carchi organised around modern technologies with the expectation of controlling nature – plants, pathogens, insect populations, etc.
• Destruction of wealth – Throughout history, cultures have systematically removed or destroyed stores of wealth – material, energy, or information. Researchers as well as farmers purposefully withhold information, and sometimes they engage in useless or harmful activities, such as questionable Safe Use of Pesticide initiatives, despite knowledge that such behaviour would continue to undermine production and the well-being of people. Villages organise to destroy forests, water and soil resources.
• Intra-specific aggression – Intra-specific violence and kill-off actually may be a latent cultural survival mechanism. Human aggression, such as that displayed at multiple points by the hacienda elite, researchers, government officials and farmers in Carchi consolidated group identity and favoured certain groups over others.
• Material fetishism – Objects can obtain symbolic value well beyond their intrinsic value, and material exchange can hinder or obscure social relationships. In Carchi, farmers spoke of pesticides "saving lives" and "providing security," thereby assigning the chemicals religious-like qualities. Mera-Orcés (2000) and Paredes (2001) identified how pesticides played a role in determining degrees of manhood.

The literature draws on a wealth of metaphors to explain the pathologies associated with modernity. For example, health professionals describe an "affliction of inequality" (Wilkinson 2001), ecologists an "environmental cognitive dissonance" (Gunderson et al., 1995), and social scientists a "creative destruction" (Schumpeter, 1987) and a "virtualization of farmers" (van der Ploeg, 2003). These diverse perspectives share at least one commonality: sustainability depends on a seeming paradox of persistence and change. At one level, it requires constant "coupling" or "embeddedness" in localities, and, at another level, it demands responsiveness to endless socio-environmental dynamics.

Gunderson and Holling's (2002) research on socio-biological development finds that the tension between persistence and change is maintained by relationships among nested sets of adaptive cycles of growth, accumulation, restructuring and renewal arranged in a dynamic hierarchy or "panarchy." They argue that modern activity has caused the self-organizing mechanisms of the system to work against human interests. For example, attempts that to hold a system in some perceived optimal state (i.e., command-and-control management) reduces both resilience and adaptability. In contrast, sustainability in a panarchic world of endless adaptive cycles depends on institutions containing high degrees of local "conservation" (i.e., coupling) and global "creativity" (dynamic innovation). As described in Chapters 5, 6, and 7, such redirection in research or development practice would face serious social obstacles, but that does not deny the substance of the argument for a redirection.

Gunderson and Holling (2002) emphasize that socio-environmental change is highly unpredictable and occurring at "moments of vulnerability." They describe three types of change in adaptive cycles: resilience, adaptability, and transformability. Resilience is the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks. Adaptability is the capacity of actors in the system to "manage" resilience for maintaining stability (i.e., move thresholds or make it easier or harder to change the system) or guide trajectories towards a desired range of outcomes. Transformability is the capacity to reorganize towards a fundamentally different system when ecological, social or economic conditions make the existing system untenable. Their general proposal for sustainable development is the organization of societies around resilience, adaptability, and transformability. In the case of Carchi, where a high degree of self-destructive human organisation was obtained, transformability would be the priority.

Holling (2000) argues that "resilience management" depends on sustaining a stability landscape (i.e., increasing the resilience of desirable outcomes and decreasing it for undesirable ones) and guiding a system's trajectory (i.e., keeping the system within a desirable range of behaviour). "Resilience governance" depends on increasing and sustaining adaptability as well as understanding and guiding social embedding in "rules." In practice, this re-direction would demand new professionalism and institutions organised around socio-environmental accountability, in turn requiring new degrees of cross-disciplinary learning and action as well as localised coupling and self-correcting mechanisms. In particular, Holling argues that effective change will require:

- Identification and reduction of destructive constraints on change, such as perverse laws and regulations that entrench self-destructive organisation
- Protection and preservation of the accumulated knowledge and experience on which change will be based
- Stimulation of locally-led innovation
- Encouragement of new foundations for renewal that build and sustain the capacity of people, economies, and nature for dealing with change
- Encouragement of new institutional foundations for consolidating and expanding new directions of change

Due to the historical moment in Carchi, I find that the back "learning and innovation" loop (see Figure 4.15) merits special attention. More sustainable rural development not only depends on achieving institutions with higher degrees of adaptive capacity and resilience. Regulatory mechanisms are sorely needed for continually coupling agricultural developments to local cultures and the environment. In order to move beyond the growing and deepening ecosystem decline in Carchi, the present policies for producing accumulated uncertainties must become reversible.

Appendix A

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Summary

Provided its natural endowments, generally educated rural population, infrastructure and market access to two countries, the Province of Carchi, located in the northernmost highlands of Ecuador, is potentially one of the most productive agriculture regions in the Andes. In the 1960s development experts and the government targeted the region as a model for agricultural modernisation. Following land reform and rapid organisation around industrial era technologies, potato farming in Carchi boomed during the 1970s, evolving to dominate the landscape and become the major source of livelihoods in the province. By the early 1980s, Carchi came to produce nearly half the national potato harvest on less than a quarter of the country's area dedicated to the crop. In the early1990s, however, production and productivity began to fall off, leading a growing number of rural families in Carchi to fall into debt and abandon potato farming.

The research reported here is the outcome of the author's ten years of research and development practice in Carchi with the International Potato Center, the FAO's Global IPM Facility, and World Neighbors. It reflects unfolding experience with different phases of hope, discovery, and ambition. Many aspects of the experience have been published elsewhere (see Appendix A). The resulting dissertation is not a case study in the sense of a case that tests a hypothesis. It is a monograph that attempts to produce a single coherent story over seemingly unrelated events, focusing on a second-generation problem: despite a decade of highly rigorous, scientific research on the pathologies of Carchi and multiple public demonstrations of feasible alternatives, little significant change was achieved.

The dissertation begins with a description of today's landscape and agriculture followed by an analysis of the pathology associated with modern potato production, in terms of human and environmental health, with major conclusions about longer-term economic feasibility and ecological sustainability. Twenty-five years following the onset of agricultural modernization, a multidisciplinary team of researchers found that the use of industrial era technologies had generated worrisome environmental, productivity and human health consequences. Tractors and total tillage became the leading cause of soil erosion, moving some 80 tons per hectare each season. Farmers spent progressively more on agrochemical inputs and received less for their commodities, leading them to lose money on well over half of their crops. Two-thirds of the rural population – including men, women and children – suffered measurable neurological damage due to exposure to highly toxic pesticides. Economic studies identified a relationship between pesticide exposure and low productivity. It had become increasingly difficult to grow a crop and to financially survive as a farmer. The research concluded with the identification of promising "impact points" for the development of scientifically supported and replicable best practice.

Before presenting the experience with the proposed interventions, the dissertation takes a step back in time to provide historical perspective on the emergence of the pathology in a high-potential agricultural area such as Carchi. Traditional *Carchense* agriculture evolved to exploit niches distributed across ecological floors, a practice described as "micro-

verticality," which permitted slow but relatively stable development in the highland Andes. Since that time, increasingly distant and exogenous influences had come to drive rural developments. The brief arrival to Carchi of the Incas followed by the Spanish Conquest and the feudal hacienda system increasingly externalised the environmental and social products of agriculture. By the decline of the hacienda system in the mid-twentieth century, traditional Andean community structure essentially had undergone transformation and the system of vertical farming was replaced by extensive, horizontally distributed agriculture, which in mountain environments proved vulnerable to the elements as well as pest and disease epidemics.

In the second half of the twentieth century, processes of agrarian reform ended the hacienda era in Carchi and provided smallholder farmers title to land and high expectations for the future. Generally, fertile valley floors continued in the hands of *hacendados*, though their landholdings were considerably smaller than before. Meanwhile, new classes of farmers became relegated to steep, though highly arable hillsides. Aggressive market integration and "technification" led to potato intensification through mechanized tillage, the introduction and increased use of agrichemicals, and a shortening of fallow periods. Over time, market forces reduced on-farm potato biodiversity. By the early 1990s, a very fragile, total tillage, external input intensive monoculture of a single, dominant variety, Superchola, dominated the landscape. These changes severely impacted the environment. Due to a compensating and then aggravating intervention of agrochemicals, they spurred ecosystem decline in the form of soil degradation, production declines, and a public health epidemic.

Research showed that from a biophysical point of view, industrial era technology enabled farmers to structurally break with nature, leading to subsequent environmental backlash. From a sociocultural perspective, people and their communities became increasingly fragmented. Individuals become detached from their psychosocial context, and collectively, people emphasized the value on the market and de-emphasized the value of neighbours, neighbourhood, and community. These two phenomena combined to produce increasing environmental and social uncertainties. By 2000, many families had experienced frustration with modernisation and the institutions championing it, with one farmer declaring, "We have done everything the *ingenieros* have told us to do, and look where we are...We are going broke." In recent times, a growing number of families decided to abandon agriculture and migrate to urban centres in search of work. Additionally, many youth joined the revolutionary groups across the nearby border with Colombia.

The dissertation continues with an ex-post examination of the implementation of the prescribed best practice aimed at addressing the pathology in Carchi, in particular through the Eco*Salud* project involving cross-disciplinary research-development practice as well as the introduction of Integrated Pest Management (IPM) through Farmer Field Schools (FFS) and policy interventions. Under the demands of project implementation, professionals from both research and development camps involved were forced to interact and negotiate interests. While this interaction sometimes led to unsatisfactory results for some, it also contributed to new skills and understanding of previously disparate perspectives. The different professional cultures of staff members (e.g. agricultural extension, participatory research, feminist social change, and health services) were built on different sets of assumptions, methods of resolving differences, planning and perceived roles in interacting with project participants. The mediation of such conflicts often carried high transaction costs.

Reflective analysis over the Farmer Field Schools provided insight into the potentials and limitations of methodology-based interventions. FFS initially provoked new thinking and creative practice at the farm level and demonstrated great potential for improving practice. Over time, however, the methodology faced limitations at leveraging broader institutional change. Following release into the "social wild," practitioners systematically cut corners, pulling FFS towards more expert-centred designs. This tendency became a dominant pattern in Carchi (and elsewhere) and thus was no mere oversight or accident, but rather the outcome of a cultural knowledge battle. The research found the methodology incompatible with dominant research and development paradigms that informed institutional designs, in particular over competing modes of knowledge production. Ultimately the conflicting perspectives of actors and institutions led them to systematically erode Field Schools to the point where much of the methodology's epistemological identity was lost. In the end, FFS scaled up in name, but not in meaning, and thereby the methodology lost much of its initial effectiveness.

The empirical experience with research-development interventions showed that the major obstacles to change in Carchi were not due to a lack of information, knowledge, technology or market alternatives, as farmers, experts, and policy makers commonly claimed. Fundamental conflicts of paradigms and process circumscribed institutional capabilities to resolve complex ecosystem health concerns. In particular, externally based proposals undermined mechanisms of social and environmental coupling. Moving towards greater accountability among science and development actors toward their localities of influence required new ways of thinking, organizing, and doing.

Critical analysis of Eco*Salud* and FFS exposed contradictions between the discourse and practice of the existing order of science and development in Carchi, at the levels of farming, science and government. A cultural power matrix surrounded the use of pesticides that informed public opinion and policy and ultimately enabled a continuation of self-destructive agriculture. It operated to entrench present regimes of thought and practice, even knowingly at the cost of the health of the majority of rural people. Socio-technical trajectory depended on the success of scientists and *técnicos* as entrepreneurs – indiscriminately mixing economic, political, natural, and cultural claims to truth. In addition to "black boxing" or myth creation, continual enrolment of new converts was a central activity. Success depended on strategic capacity of networks to continually grow and shape perspective.

The findings led to the major conclusion that best practice and public knowledge of the same are not enough to foment social change, be it at the level of farmers, extensionists and facilitators, commercial companies, public agencies or politicians, such as ministers of agriculture. In fact, at all levels, major stakeholders seemed to be locked into a non-adaptive, lethal, and eventually self-destructive system of food production. Over time, Carchi had become a theatre of risk, as described by Beck (1992) and Beck et al. (1994). The dangers of agriculture technologies became so far-reaching and generalised that it was no longer possible to place the blame on an individual, such as a farmer or pesticide salesperson. The guilty party had become "The System." At first, the abstractions of pesticide poisonings and environmental degradation made their effects "invisible" and difficult to track and perceive. Nevertheless, once research made explicit those effects (for example, through quantitative measurement of neurological damages and soil losses), a powerful class of brokers that had grown around agriculture technologies kept them invisible. These actors – chemists, agriculture researchers, extension agents, salespeople, and regulatory officials – manoeuvred, strategised, collaborated and colluded to influence public opinion and sustain harmful technology.

Integrated analysis of the experience identified a number of conclusions over the institutional features of modern agriculture in Carchi, including:

1) The risks associated with pesticides were essentially invisible and subject to interpretation. As a result, it was not rationality but the successful entrepreneurship of actors that informed public perception and determined policy outcomes.
2) The risks associated with the practice of modern agriculture crossed disciplinary boundaries and demanded bridging between arbitrary lines dividing knowledge and practice, policy and action, internalities and externalities. Expert-oriented institutions were incapable of mediating these differences, and in fact, they played a central role in creating and representing the myths and conceptual blindfolds that prevented people from seeing alternatives.
3) The "bads" (i.e., harmful outcomes) of industrial-era agriculture led to backlash, in this case clearly both ecological and social. The effect appeared to go beyond a mere reorganization of *Carchense* society to a more fundamental breakdown and system decline.
4) Ultimately, modernisation in Carchi psychologically and socially distanced people from their locality, leading to diverse forms of fragmentation with local experience and a sense of alienation from family, community, and broader society. As a result, it appeared that people had lost the ability to regulate change or collectively respond to the accelerating events of modern times, leading to different forms of violence.

Based on these outcomes, the research concluded that today's institutions are structurally tied to the same logic and value systems that induce and sustain the problematic qualities of modernity. As a result, in their attempt to address ecosystem crisis, science and development inevitably contribute to its deepening. Such tendencies produce contradictions that undermine the legitimacy of institutions. Nevertheless, due to the effectiveness of the socio-technical regime as a social networker and powerbroker, self-destructive policy became entrenched. From the experience in Carchi, it appears unlikely that profound change could emerge from within present frameworks.

According to the "adaptive management" and "resilience" literature, as summarised in Gunderson and Holling (2002), sustainability depends on a seeming paradox of persistence and change. At one level, it requires constant "coupling" or "embeddedness" in localities, and at another level it demands responsiveness to endless socio-environmental dynamics. Sustainability in a "panarchic" world of endless adaptive cycles depends on institutions containing high degrees of local "conservation" (i.e., coupling) and global "creativity" (dynamic innovation). The experience in Carchi showed that such movement in research or development practice would face strong resistance, but that does not deny the substance of the argument for redirection. According to this perspective, a general proposal of sustainable development becomes the organization of societies around resilience, adaptability, and transformability. Resilience is the capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks. Adaptability is the capacity of actors in the system to manage resilience for maintaining stability or guide trajectories towards a desired range of outcomes. Transformability is the capacity to reorganize towards a fundamentally different system when ecological, social or economic conditions make the existing system untenable. In the case of Carchi, where a high degree of self-destructive human organisation had been obtained, institutional transformation had become the priority for more promising futures.

Resumen

Dados sus recursos naturales, una población rural mayormente educada, infraestructura y acceso al mercado en dos países, la provincia del Carchi, localizada en la Sierra Norte del Ecuador, es potencialmente una de las regiones agrícolas más productivas en los Andes. En los años 60 los expertos en desarrollo y el gobierno ecuatoriano enfocaron en la región como un modelo de modernización agrícola. Luego de la reforma agraria y una rápida organización alrededor de las tecnologías de la era industrial, la producción de papas en Carchi floreció durante los años 70, desarrollándose hasta dominar el paisaje y transformarse en la principal fuente de ingresos en la provincia. Al inicio de los años 80, Carchi llegó a producir cerca de la mitad de la cosecha nacional de papas en menos de la cuarta parte del área nacional dedicada a este cultivo. Al inicio de los 90, sin embargo, la producción y la productividad comenzaron a caer, llevando a un número creciente de familias rurales en Carchi a endeudarse y a abandonar el cultivo de papa.

La presente investigación es el resultado de diez años de investigación e intervención del autor junto con el Centro Internacional de la Papa, la Facilidad Global de MIP de la FAO y Vecinos Mundiales en Carchi. Esta refleja la experiencia desplegada con diferentes fases de esperanza, descubrimiento y expectativa. Muchos aspectos de la experiencia han sido publicados en otras partes (ver el Apendice A). La disertación resultante no es un caso de estudio en el sentido de que busca probar una hipótesis. Es mas bien una monografía que trata de producir una historia coherente sobre eventos aparentemente no relacionados entre sí, enfocando en un problema de segunda generación: a pesar de una década de investigación científica altamente rigurosa sobre la patología del Carchi y la demostración pública de alternativas factibles, se han logrado poquísimos cambios significativos.

Esta disertación comienza con una descripción del paisaje actual y de la agricultura, seguida por un análisis de la patología asociada con la producción moderna, en términos de la salud humana y ambiental, con conclusiones importantes sobre la factibilidad económica y sostenibilidad ecológica de largo plazo. Veinte y cinco años luego de la llegada de la modernización agrícola, un equipo multidisciplinario de investigadores encontraron que el empleo de las tecnologías de la era industrial había generado consecuencias ambientales, de productividad y salud humana preocupantes. Los tractores y la labranza total se convirtieron en la causa principal de erosión del suelo, removiendo unas 80 toneladas de suelo por hectárea en cada ciclo de producción. Los agricultores gastaban progresivamente más en insumos agroquímicos y recibían menos por sus productos, conduciéndoles a perder dinero en una buena mitad de sus cultivos. Dos tercios de la población rural – incluyendo, hombres, mujeres y niños- sufrían daños neurológicos medibles debido a la exposición a plaguicidas altamente tóxicos. Estudios económicos identificaron una relación entre exposición a plaguicidas y baja productividad. Se había hecho crecientemente difícil producir un cultivo y sobrevivir como agricultor. La investigación concluye con la identificación de "puntos de impacto" prometedores para el desarrollo de "mejores prácticas" replicables y apoyadas científicamente.

Antes de presentar la experiencia con las intervenciones propuestas, la disertación da un paso atrás en el tiempo para proveer una perspectiva histórica sobre la emergencia de la patología en un área con alto potencial agrícola como es Carchi. La agricultura tradicional carchense se desarrolló para explotar nichos distribuidos a través de pisos ecológicos, una práctica descrita como "micro-verticalidad," la cual permitió el desarrollo lento pero estable en los altos Andes. Desde ese tiempo, crecientes influencias distantes y externas han llegado a dirigir el desarrollo agrícola. El breve arribo de los Incas a Carchi seguido por la conquista española y el sistema feudal de hacienda externalizaron crecientemente los resultados ambientales y sociales de la agricultura. Al declinar del sistema de hacienda a mediados del siglo 20, la estructura tradicional de la comunidad Andina sufrió transformaciones esenciales y el sistema de agricultura vertical fue reemplazado por una agricultura extensiva distribuida horizontalmente, la cual, en ambientes montañosos ha probado ser vulnerable tanto a los elementos como a las epidemias de plagas y enfermedades.

En la segunda mitad del siglo 20 los procesos de reforma agraria dieron fin a la era de la hacienda en Carchi y proveyeron a los pequeños agricultores de títulos de propiedad y altas expectativas para el futuro. Generalmente, los suelos fértiles de los valles continuaron en manos de hacendados, aunque sus propiedades quedaron considerablemente mas pequeñas que antes. Mientras tanto la nueva clase de agricultores fue relegada a laderas pendientes aunque también altamente arables. La integración agresiva a los mercados y la "tecnificación" dirigió la intensificación de la producción de papa a través de la labranza total, la introducción y el creciente uso de agroquímicos y un acortamiento de períodos de descanso. Con el tiempo, las fuerzas del mercado redujeron la biodiversidad de papas en las fincas. A inicios de los años 90, un muy frágil monocultivo de uso intensivo de insumos externos, de labranza total y uso de una sola variedad principal, Superchola, dominó el paisaje. Estos cambios impactaron severamente al ambiente y, debido a la intervención agravante y compensatoria de los agroquímicos, fomentaron el declinar del ecosistema en forma de degradación de suelo, caídas de producción y una epidemia de salud pública.

La investigación demuestra que desde un punto de vista biofísico, la era tecnológica industrial permitió a los agricultores romper estructuralmente con la naturaleza, provocando así una fuerte respuesta ambiental. Desde una perspectiva socio-cultural, la gente y sus comunidades se fragmentaron crecientemente tanto a nivel de individuos sico-socialmente (un sentido de desconexión del contexto) y colectivamente (una tendencia hacia valorar el mercado por sobre los vecinos, el barrio y la comunidad). Estos dos fenómenos combinados para producir el declinar socio-biológico se caracterizó por una creciente incertidumbre ambiental y social. En el año 2000, muchas familias experimentaron frustración con la modernización y las instituciones que la promovían como lo explicó un agricultor, "Hemos hecho todo lo que los ingenieros nos dijeron y miren donde estamos… Estamos yendo a la quiebra." En tiempos recientes un número creciente de familias decidieron abandonar la agricultura y migrar a centros urbanos en búsqueda de trabajo. Adicionalmente, muchos jóvenes se integraron a grupos revolucionarios a lo largo de la frontera cercana con Colombia.

La disertación continúa con un examen ex post de la implementación de las mejores prácticas prescritas orientadas al tratamiento de la patología en Carchi, en particular a través del proyecto Eco*Salud* que involucró investigación-desarrollo transdisciplinario así como la introducción del Manejo Integrado de Plagas (MIP) a través de las Escuelas de Campo de Agricultores (ECAs) e intervención en políticas. Bajo las demandas de implementación del proyecto, profesionales involucrados tanto en el campo de investigación como de desarrollo se vieron obligados a interactuar y negociar intereses. Mientras la interacción algunas veces condujo a resultados insatisfactorios para algunos, esta también contribuyó a nuevas habilidades y entendimiento de perspectivas antes distantes. Las diferentes culturas profesionales de los miembros del equipo (por ejemplo de extensión agrícola, investigación participativa, cambio social feminista y servicios de salud) se construían en diferentes supuestos, métodos de resolución de diferencias, planificación y roles percibidos en la interacción con los participantes del proyecto. La mediación de tales conflictos a menudo significó altos costos de transacción.

El análisis reflexivo de las Escuelas de Campo de Agricultores permitió la comprensión de los potenciales y limitaciones de las intervenciones basadas en metodologías. Las ECA inicialmente provocaron nuevas ideas y practicas creativas a nivel de finca y demostraron gran potencial para mejorar la práctica. En el tiempo, sin embargo, la metodología enfrentó limitaciones para promover cambios institucionales más amplios. Luego de liberadas en el mundo social, los practicantes sistemáticamente "cortaron esquinas," llevando las ECA hacia diseños más centrados en los expertos. Esta tendencia se volvió el patrón dominante en Carchi (y otros lugares) y no fue descuido o accidente, pero el resultado de una batalla cultural de conocimientos. La investigación encontró a la metodología incompatible con los paradigmas dominantes de investigación y desarrollo que informaban los diseños institucionales, en particular sobre los modos de producción de conocimientos en competencia. Finalmente las perspectivas conflictivas de los actores y las instituciones condujo a erosionar sistemáticamente las escuelas de campo al punto de que mucho de la identidad epistemológica de la metodología se perdió. Al final las ECA se difundieron por su nombre pero no por su significado y la metodología perdió mucho de su eficiencia inicial.

La experiencia empírica con intervenciones de investigación-desarrollo demostraron que los mayores obstáculos al cambio en Carchi no fueron debido a "faltas" de información, conocimiento, tecnología o alternativas de mercado, como agricultores, expertos y formadores de políticas comúnmente afirmaban. Los conflictos fundamentales de paradigmas y procesos circunscribieron las capacidades institucionales para resolver problemas complejos de salud del ecosistema. En particular, las propuestas externas socavaron los mecanismos de acoplamiento social y ambiental (i.e., prácticas agrícolas mas comunitarias y ecológicas). Moverse hacia una mayor "responsabilidad" de la ciencia y el desarrollo con lo local requería de nuevas formas de pensamiento, organización y práctica.

El análisis crítico de Eco*Salud* y de las ECA expuso las contradicciones entre el discurso y la práctica en el orden existente de la ciencia y el desarrollo en Carchi, al nivel de la producción, la ciencia y el gobierno. Una matriz cultural de poder rodeó el uso de plaguicidas e informó la opinión pública y las políticas y finalmente permitió la continuación de la agricultura auto-destructiva. Ello operó estancando los regímenes existentes de pensamiento y practica, aun conociendo el costo que representaba para la salud de la mayoría de la gente rural. La trayectoria socio-técnica dependió del éxito de los científicos y técnicos como empresarios – mezclando indiscriminadamente pretensiones de verdad económica, política, natural y cultural. En adición a la creación de “cajas negras” o mitos, el enrole continuo fue una actividad central. El éxito dependió de la capacidad estratégica de las redes para crecer continuamente e informar las perspectivas.

Los resultados de la investigación llevan a la conclusión principal de que la mejor práctica y la demostración pública de lo mismo no son suficientes para fomentar el cambio social, sea a nivel de los agricultores, extensionistas, facilitadotes, compañías comerciales, agencias públicas o políticas, tales como el ministerio de agricultura. En realidad, a todos los niveles, los principales interesados parecen estar acoplados a un sistema de producción no-adaptativo, letal y eventualmente auto-destructivo (i.e., del punto de vista financiero, de salud humana y fertilidad del suelo). En el tiempo, Carchi se ha vuelto un teatro de riesgo, tal como lo describen Beck (1992) y Beck et al. (1994). Los peligros de las tecnologías agrícolas se han vuelto generalizados y difíciles de sobrellevar que no es posible echar la culpa a un solo individuo agricultor o vendedor de plaguicidas. El culpable se ha vuelto el “Sistema.” Al inicio, la abstracción sobre las intoxicaciones por plaguicidas y la degradación ambiental tenían efectos “invisibles” y difíciles de tratar y percibir. Sin embargo, una vez que la investigación hizo explícitos esos efectos, por ejemplo a través de medidas cuantitativas de los daños neurológicos y pérdidas de suelo, una clase poderosa de agentes que ha crecido alrededor de las tecnologías agrícolas los siguieron manteniendo “invisibles.” Estos actores –químicos, investigadores agrícolas, agentes de extensión, vendedores y oficiales de agencias reguladoras- maniobraron, armaron estrategias, colaboraron y confabularon para influenciar la opinión pública y mantener las tecnologías dañinas.

El análisis integrado de la experiencia identificó conclusiones sobre las características institucionales de la agricultura moderna en Carchi las cuales incluyen:

1) Los riesgos asociados con plaguicidas fueron esencialmente invisibles y sujetos a interpretación. Como resultado, no fue la racionalidad científica pero la capacidad empresarial exitosa de los actores lo que informó la percepción pública y determinó los resultados en políticas.
2) Los riesgos asociados con la práctica de la agricultura moderna cruzaron las fronteras disciplinarias y demandaron vínculos entre líneas arbitrarias dividiendo conocimiento y práctica, políticas y acción, internalidades y externalidades. Instituciones centradas en los expertos fueron incapaces de mediar estas diferencias, y en realidad, ellos jugaron un rol central en la creación y la representación de los mitos y las vendas conceptuales que evitaron que la gente vea las alternativas.
3) Los “males” de la era industrial agrícola condujeron a una respuesta fuerte, en este caso claramente ecológica y social. El efecto parece ir mas allá de una mera reorganización de la sociedad carchense pero hacia un quiebre mas fundamental y un declinar del Sistema.

4) Finalmente, la modernización en Carchi distanció a la gente sicológica y socialmente de su localidad, conduciendo a diversas formas de fragmentación con la experiencia local y un sentido de alienación de la familia, la comunidad y la sociedad. Como resultado, parece que la gente perdió la habilidad de regular el cambio o responder colectivamente a los eventos acelerados de los tiempos modernos, llevándola a diferentes expresiones de violencia.

Basados en estos resultados, la investigación concluyó que las instituciones presentes estaban estructuralmente vinculadas a la misma lógica y sistemas de valor que inducen y sostienen las cualidades problemáticas de la modernidad. Como resultado, en su intento de dirigir la crisis del ecosistema, la ciencia y el desarrollo inevitablemente contribuyen a su profundización. Tales tendencias producen contradicciones que socavan la legitimidad de las instituciones. Sin embargo, debido a la efectividad del régimen socio-técnico como un armador de redes y agente de poder, la política auto-destructiva se mantiene. De la experiencia de Carchi, parece poco probable que el cambio profundo podría surgir desde el interior de los presentes escenarios.

De acuerdo a la literatura de "manejo adaptativo" y "acoplamiento," como se resume en Gunderson y Holling (2002), la sostenibilidad depende de una aparente paradoja de persistencia y cambio. A un nivel, requiere de constante "acoplamiento" o "inmersión" en la localidad, y a otro nivel demanda "responsabilidad" con la interminable dinámica socio-ambiental. La sostenibilidad en un mundo "panárquico" de ciclos adaptativos interminables depende de instituciones que contengan altos grados de "conservación" local (i.e., el acoplamiento ecológico de algunos agricultores con la localidad) y "creatividad" global (innovación dinámica coherente con los potenciales ecológicos y sociales de la localidad). La experiencia en Carchi demostró que tal movimiento en investigación o en la práctica del desarrollo enfrentaría una fuerte resistencia, pero eso no niega la necesidad de una redirección. De acuerdo a esta perspectiva, una propuesta general de desarrollo sostenible se transforma en la organización de sociedades alrededor del acoplamiento, adaptabilidad y transformabilidad. Acoplamiento es la capacidad de un sistema de absorber perturbaciones y reorganizarse mientras enfrenta cambios, de manera que aún retenga esencialmente la misma función, estructura, identidad y retroalimentación. Adaptabilidad es la capacidad de los actores en el sistema para "manejar" el acoplamiento y mantener estabilidad (i.e., mover umbrales o hacer mas fácil o difícil cambiar el sistema) o guiar trayectorias hacia un rango deseado de respuestas. Transformabilidad es la capacidad de reorganización hacia un sistema fundamentalmente diferente cuando las condiciones ecológicas, sociales o económicas hacen del sistema existente insostenible. En el caso de Carchi, donde el resultado ha sido un alto grado de auto-destrucción de la organización social, la reorganización institucional alrededor de la transformabilidad se ha vuelto una prioridad para futuros más prometedores.

Samenvatting

De provincie Carchi ligt in de meest noordelijke hooglanden van Ecuador. Het is potentieel een van de meest productieve regio's in de Andes dankzij de vele natuurlijke hulpbronnen, de in het algemeen goed opgeleide bevolking, de aanwezige infrastructuur en toegang tot markten. In de jaren zestig gingen ontwikkelingsdeskundigen en de regering deze regio gebruiken als model voor landbouwmodernisering. Na landhervormingen en een snelle invoering van technologie uit het industriële tijdperk, groeide, in de jaren zeventig, de aardappelproductie in Carchi snel. De aardappelteelt werd een dominant element in het landschap en een van de belangrijkste inkomstenbronnen in de provincie. In de vroege jaren tachtig produceerde Carchi bijna de helft van het nationale volume op minder dan een kwart van het nationale oppervlak voor aardappelproduktie. In het begin van de jaren negentig begonnen de productie en productiviteit echter af te nemen. Dat leidde tot een groeiend aantal boerenfamilies met schulden. Vele van hen verlieten de landbouw.

Het hier gepresenteerde onderzoek is het resultaat van tien jaar werk voor de volgende organisaties: "International Potato Center, "Global IPM Facility" van de FAO, en "World Neighbours." Het geeft verschillende periodes weer van hoop, ontdekking en ambitie. Veel hiervan is elders gepubliceerd (zie Appendix A). Dit proefschrift is geen "case study" in de zin van een onderzoek naar een specifieke situatie die een hypothese test. Het is een monografie die een poging doet om een coherent verhaal te vertellen over schijnbaar ongerelateerde gebeurtenissen met aandacht voor het volgende tweede generatie probleem: ondanks een decennium van intensief onderzoek naar de pathologien in Carchi en vele publieke demonstraties van werkbare alternatieven voor de aardappelteelt is weinig significante verandering bereikt.

Dit proefschrift begint met een beschrijving van het huidige landschap en landbouw. Daarna volgt een analyse van de manier waarop de moderne aardappelproductie de gezondheid van mens en omgeving aantast. Er worden een aantal hoofdconclusies getrokken over economische haalbaarheid en ecologische duurzaamheid op lange termijn. Vijfentwintig jaar na het begin van de landbouwmodernisering vond een multidisciplinair team van onderzoekers dat het toepassen van technologie uit het industriële tijdperk in Carchi tot schadelijke effecten had geleid voor het milieu, de productiviteit en gezondheid. Tractoren en intensieve grondbewerking veroorzaakten bodemerosie, met verlies aan bodemmateriaal van 80 ton per ha per seizoen. Boeren gebruikten steeds meer chemische gewasbeschermingsmiddelen. Ze ontvingen steeds minder voor hun producten, waardoor verlies werd geleden op meer dan de helft van hun oogsten. Bij tweederde van de boerenbevolking – mannen, vrouwen en kinderen – was meetbaar neurologisch letsel vastgesteld veroorzaakt door blootstelling aan sterk toxische pesticiden. Economische studies gaven een relatie aan tussen blootstelling van de boerenbevolking aan pesticiden en lage productiviteit. Het was steeds moeilijker geworden om aardappelen te verbouwen en daar financieel van rond te komen. De studies mondden uit in conclusies over de relatie tussen pesticidengebruik en productiviteit. Ze gaven aanbevelingen in de vorm van veelbelovende "actie punten" voor de ontwikkeling van wetenschappelijk bewezen en herhaalbare "beste landbouwmethoden" (*best practice*).

Voordat de ervaringen met deze beste landbouwmethoden worden gepresenteerd in dit proefschrift, wordt er een historisch perspectief gegeven van de opkomst van ziektenbeelden in een landbouwgebied met groot potentieel zoals Carchi. De traditionele *Carchense* landbouw ontwikkelde zich door niches te gebruiken over verschillende ecologische hoogtezones. Deze praktijk, die wordt omschreven als "micro-verticaalheid," stond een langzame maar relatief stabiele ontwikkeling toe in de hooglanden van de Andes. In de loop van de tijd werd een toenemende en verder reikende invloed van buiten een belangrijke sturende factor voor de agrarische ontwikkeling. Een kortdurende aanwezigheid van de Incas, gevolgd door de Spaanse verovering en het feodale *haciënda* systeem, externaliseerden in toenemende mate de natuurlijke en sociale landbouwproducten. Toen het *haciënda* systeem in het midden van de twintigste eeuw in verval raakte, had de traditionele gemeenschapsstructuur een transformatie ondergaan en was het systeem van "micro-verticaalheid vervangen door extensieve, horizontaal verspreide landbouw. Deze landbouw is juist in bergomgevingen kwetsbaar voor de elementen, plagen en ziekten.

In de tweede helft van de twintigste eeuw maakten landhervormingen een eind aan de *haciënda* tijd in Carchi. Kleinschalige boeren kregen eigendom van hun land en hadden hoge verwachtingen voor de toekomst. De vruchtbare grond in dalen bleef in handen van de eigenaren van de *haciënda's* maar de hoeveelheid land die ze bezaten was aanzienlijk minder dan voorheen. De grond van de nieuwe klasse kleinschalige boeren was beperkt tot steile, maar makkelijk bewerkbare hellingen. In dezelfde tijd vond een agressieve integratie in markten plaats, gelijktijdig met een intensivering van de aardappelproductie door mechanisering, toenemend gebruik van chemische bestrijdingsmiddelen en steeds kortere rotaties. Het compenserende en toenemende gebruik van chemische middelen veroorzaakten een verval van ecosystemen door bodemdegradatie, afname van de productie en epidemieën in de publieke gezondheid. De marktwerking zorgde voor een afname van het aantal aardappelvariëteiten. In het begin van de jaren negentig begon de *Superchola* variëteit in monocultuur te domineren. Dit was een zeer kwetsbare variëteit die verbouwd werd na intensieve grondbewerking en afhankelijk was van externe productiemiddelen als pesticiden en kunstmest.

Onderzoek liet zien dat de nieuwe technologien en druk van buitenaf boeren verleidde om structureel te breken met de natuur. Dat had zware gevolgen voor het milieu. Tevens raakten mensen en gemeenschappen steeds meer gefragmenteerd, zowel individueel/psychosociaal (een gevoel van gebrek aan verbondenheid met de context) als collectief (een ontwikkeling richting voorkeur voor de markt in plaats van voor de buren, buurtschap en gemeenschap). De combinatie van deze twee fenomenen leidde tot een verslechtering van de sociale en biologische situatie. Deze verslechtering werd gekarakteriseerd door toenemende onzekerheid over het milieu en de sociale omstandigheden. In 2000 waren er reeds vele families gefrustreerd door de modernisering en de organisaties die de modernisering aanmoedigden, zoals blijkt uit de woorden van een boer: "We hebben alles gedaan wat de ingenieurs ons hebben verteld en kijk eens hoe we er voor staan..... we gaan failliet." De laatste jaren hebben een toenemend aantal families besloten de landbouw te verlaten en naar steden te migreren op zoek naar werk. Ook hebben vele jongeren zich aangesloten bij revolutionaire groeperingen over de grens in Colombia.

Na dit historisch perspectief van de opkomst van pathologien vervolgt dit proefschrift met een *ex-post* onderzoek naar de toepassing van aanbevolen beste landbouwmethoden die het ziektebeeld van Carchi probeerden op te lossen. Het gaat, in het bijzonder over het *EcoSalud* project waarin multidisciplinair onderzoek, ontwikkeling, geïntegreerde bestrijding van plagen (*Integrated Pest Management*, IPM), Boeren Veld Scholen (*Farmer Field Schools*, FFS) en politiek beleid wordt toegepast. Bij dat project waren deskundigen in onderzoek en ontwikkeling gedwongen samen te werken en over hun belangen te onderhandelen. Hoewel dit voor sommigen soms onbevredigend was, hielp het ook om nieuwe capaciteiten te ontwikkelen en uiteenlopende meningen beter te begrijpen. De verschillende betrokken projectmedewerkers (bijvoorbeeld vanuit landbouwvoorlichting, participatief onderzoek, feministische sociale verandering, gezondheid hanteerden bij aanvang elk hun eigen, beroepscultuur bepaalde aannames, methodes voor het oplossen van geschillen, planning en rollen in de interactie met projectdeelnemers. Het oplossen van zulke verschillen was tijdrovend en bracht vaak hoge kosten met zich mee.

Een analyse van FFS gaf inzicht in de mogelijkheden en beperkingen om vanuit methodologische hoek interventies toe te passen. FFS bracht in het begin een nieuwe manier van denken op gang. De daardoor ontstane creatieve toepassing van nieuwe methoden demonstreerde een groot potentieel voor verbetering. Maar met de tijd werd duidelijk dat de methodologie beperkingen had voor het tot stand brengen van veranderingen in de instituties. Het bleek dat na het toepassen van FFS in de sociale praktijk, de deelnemers systematisch op zoek gingen naar ontwerpen gebaseerd op deskundigenkennis. Dit werd de overheersende tendens in Carchi (en elders) en was eerder het gevolg van een veldslag van cultureel bepaalde kennis dan toeval. Onderzoek liet zien dat de FFS methodologie niet compatibel was met de overheersende onderzoeks- en ontwikkelingsparadigma's waarop institutionele ontwerpen gebaseerd waren, vooral wat betreft verschillende modellen voor kennisproductie.
De botsende perspectieven van actoren en instituties leidde ertoe dat FFS systematisch werd uitgehold totdat veel van de epistemologische identiteit van de methodologie verloren ging. Op het laatst was de naam FFS steeds bekender maar betekende FFS steeds minder. De methodologie had veel van zijn effectiviteit van de begindagen verloren

De praktijkervaring met onderzoek en ontwikkeling interventies liet zien dat de belangrijkste obstakels voor verandering in Carchi niet het gevolg waren van gebrek aan informatie, kennis, technologie of markten, zoals boeren, deskundigen en beleidsmakers in het algemeen beweerden. Fundamentele verschillen in paradigmas en processen beperkten de institutionele capaciteit om complexe problemen met de gezondheid van ecosystemen op te lossen. Vooral voorstellen van buitenaf ondermijnden de mechanismen die van oudsher het milieu met de sociale processen verbonden. Meer oplossingsgerichte wetenschap en meer verantwoordelijkheid voor de locale bevolking vereisten nieuwe manieren van denken, organiseren en doen.

Een kritische analyse van *EcoSalud* en FFS toonden tegenstellingen aan tussen de gestelde bedoelingen en de praktijk van de bestaande instituties in Carchi, zowel op het gebied van landbouw, wetenschap als regering. Een culturele machtstructuur beheerste het gebruik van pesticiden en informeerde tegelijkertijd de publieke opinie en de politiek. Zo werd een voortzetting van zelfdestructieve landbouw mogelijk. Het zorgde voor het consolideren van bestaande systemen van denken en doen, zelfs terwijl het duidelijk was dat dit ten koste ging van de gezondheid van de meerderheid van de boeren bevolking. Het sociaaltechnische traject hing af van het succes van wetenschappers en technici als ondernemers. Zij legden zonder onderscheid economische, politieke, milieu gerelateerde en culturele claims op de waarheid. Naast het presenteren van "zwarte dozen" en het creëren van mythes, was het verzekeren van nieuwe gebruikers een centrale activiteit. Hun succes hing af van de strategische capaciteit van netwerken om continue te groeien en nieuwe perspectieven te vormen.

De bevindingen van dit onderzoek leidden tot de conclusie dat beste methoden en het publiekelijk aantonen ervan niet genoeg waren om de daaruit voortvloeiende noodzakelijke sociale verandering teweeg te brengen bij boeren, voorlichters, commerciële bedrijven, publieke instellingen of politici, zoals ministers van landbouw. Op alle niveaus leken de belangrijkste betrokkenen opgesloten te zitten in een niet flexibel, lethaal en zelfdestructief (vanuit financieel, gezondheids en bodemvruchtbaarheids perspectief) voedselproductiesysteem. Met de tijd was Carchi het "theater van de risico's" geworden, zoals Beck (1992) en Beck et al. (1994) het beschrijven. De gevolgen van de ontstane landbouwpraktijken waren zo verreikend en algemeen geworden dat het niet mogelijk was om een individu de schuld te geven, zoals een boer of een verkoper van pesticiden. Het "systeem" was de schuldige partij geworden. In het begin waren door de abstracties van pesticidenvergiftigingen en milieudegradatie de effecten moeilijk te traceren en waar te nemen. Toen wetenschappelijk onderzoek de effecten aantoonde, bijvoorbeeld door kwantitatieve metingen van neurologische schade en verlies van bodems, werden de effecten buiten beeld gehouden door machtige groepen "makelaars" die waren ontstaan rond landbouwtechnologie. Deze actoren – chemici, landbouwonderzoekers, voorlichters, verkopers en regulerende instanties – manoeuvreerden, zochten strategieën en werkten en spanden samen om de publieke opinie te beïnvloeden en schadelijke technologie in stand te houden.

Een geïntegreerde analyse van de ervaringen heeft geleid tot een aantal conclusies over de institutionele karakteristieken van de moderne landbouw in Carchi:

1. De risico's die samenhangen met pesticidengebruik waren onzichtbaar en onderwerp van interpretatie. Dit had tot gevolg dat het niet de redelijkheid was maar succesvol ondernemerschap van actoren dat de publieke perceptie informeerde en de politieke resultaten bepaalde.
2. De risico´s die samenhangen met moderne landbouw overschreden disciplines. Dat vereiste het overbruggen van de grenzen tussen kennis en praktijk, beleid en actie, internaliteiten en externaliteiten. Deskundigheid-georienteerde instituties waren daartoe niet in staat. Ze speelden in feite een centrale rol in het creëren en

vertegenwoordigen van de mythes en conceptuele blinddoeken die er voor zorgden dat mensen geen alternatieven zagen.

3. De slechte kanten van de op het industriële tijdperk geënte landbouw leidden tot een terugslag, zowel ecologisch als sociaal. Dit effect ging verder dan alleen een reorganisatie van de Carchi gemeenschappen en veroorzaakte een fundamentele instorting en verval van het produktiesysteem.
4. Uiteindelijk ontwortelde de modernisering in Carchi mensen zowel psychologisch als sociaal van hun locatie, hetgeen leidde tot verschillende vormen van fragmentatie met locale ervaring en een gevoel van onthechting van familie, gemeenschap en de maatschappij. Als gevolg daarvan leek het dat mensen de capaciteit hadden verloren om met verandering om te gaan of om collectief te reageren op de snelle opeenvolging van gebeurtenissen gerelateerd aan moderne tijden, hetgeen leed tot verschillende vormen van geweld.

Gebaseerd op deze resultaten, concludeert dit onderzoek dat de huidige instituties nog steeds structureel vasthouden aan dezelfde logica en waardesystemen die de problematische kwaliteiten van moderniteit intensiveren en in stand houden. Het gevolg is dat wetenschap en ontwikkeling in hun poging om een ecosysteem crisis op te lossen, onvermijdbaar bijdragen tot verergering. Deze tendenties produceren tegenstellingen die de legitimiteit van instituties ondermijnen. Desondanks wortelde dit destructieve beleid zich sterk door de effectiviteit van het sociaaltechnische regime als sociaal netwerker en machtsmakelaar. Op basis van de ervaring in Carchi lijkt het onwaarschijnlijk dat er grondige veranderingen zullen komen binnen de huidige structuren.

Volgens de literatuur over veerkracht ("resilience"), samengevat door Gunderson and Holling (2002), hangt duurzaamheid af van een schijnbare paradox van persistentie en verandering. Op één niveau behoeft het een constante verbinding of verbondenheid met lokaliteiten en op een ander niveau heeft de responsiviteit nodig op eindeloze sociale en omgevingsdynamiek. Duurzaamheid in een panarchistische wereld met eindeloze adaptieve cirkels hangt af van de een hoge graad van lokale "bescherming" (verbondenheid) en globale "creativiteit" (dynamische vernieuwing) van instituties. De ervaring in Carchi liet zien dat zulke verandering in wetenschap of ontwikkelingswerk sterke weerstand zou oproepen, maar dit weerspreekt de basis voor het argument voor nieuwe richtingen niet. Vanuit dit oogpunt, wordt een algemeen voorstel voor duurzaamheid de organisatie van gemeenschappen rond veerkracht, aanpassingkracht en transformatiekracht. Veerkracht is de capaciteit van een systeem om verstoring op te vangen en om te transformeren onder verandering om zo in essentie dezelfde functie, structuur identiteit en terugkoppeling te behouden. Aanpassingskracht is de capaciteit van actoren in het systeem om veerkracht toe te passen voor het behoud van stabiliteit (verandering van drempels of het makkelijker/moeilijker maken om het systeem te veranderen) of trajecten te begeleiden richting gewenste uitkomsten. Transformatiekracht is de capaciteit om te reorganiseren in de richting van een fundamenteel verschillend systeem, op het moment dat het huidige systeem onhoudbaar wordt door de ecologische, sociale of economische condities. In het geval van Carchi, waar een hoge mate van zelfdestructieve menselijke organisatie was ontstaan, waren institutionele reorganisaties rond transformatiekracht de prioriteit geworden voor een betere toekomst.

Curriculum vitae

Born in Richmond, Virginia, Stephen Sherwood has lived and worked in Central and South America for over 20 years. Prior to initiating PhD research with the Communications and Innovation Studies Group at Wageningen University in The Netherlands, he studied international development and economics at Penn State University and plant pathology and adult education at Cornell University in the United States.

Steve began his international career in 1988 as a Peace Corps Volunteer in Honduras, where he worked with a network of farmers to advance maize-based green manure and covercrop systems. Following assorted technical training and development activities in Guatemala and Nicaragua, he became the Central American Coordinator for the Cornell International Institute for Food, Agriculture and Development, where he led research and training initiatives on soil conservation, agroecology, and socio-environmental conflict management. In 1998, Steve moved to Ecuador to work with the International Potato Center and the Food and Agriculture Organization's Global IPM Facility to introduce Farmer Field School methodology in Latin America. In 2005, he became the Andes Area Representative for World Neighbors, an organization advocating grassroots development in remote regions. Recently, Steve co-founded EkoRural, which supports research and development activities in favour of healthier food systems as well as PeaksOverPoverty, linking outdoor enthusiasts with fundraising on behalf of mountain people.

His wife, Myriam Paredes, and he own an organic farm in the highlands of Ecuador, where they are involved in a number of rural peoples' movements. Steve has co-authored and -edited diverse academic and practitioner publications on agriculture and rural development, including *El Cultivo de la Papa en Ecuador*, *El Cultivo de Granos Andinos*, *Herramientas de Aprendizaje*, and *Guia Metodológica de Escuelas de Campo de Agricultores en America Latina.*

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