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**Fakultet för landskapsplanering,
trädgårds- och jordbruksvetenskap**

Evaluation of Integrated Pest Management (IPM) adoption in potato production using the Sustainable Livelihoods Approach

– A qualitative study from central Ecuador

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Master's Thesis in Agricultural Science • 30 HEC • Advanced level, A2E
Agroecology – Master's programme • Självständigt arbete vid LTJfakulteten, SLU
Alnarp 2013

Evaluation of Integrated Pest Management (IPM) adoption in potato production using the Sustainable Livelihoods Approach – a qualitative study from central Ecuador

Titel på engelska

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Type of student project: Master Thesis
Credits: 30 credits
Education cycle: Advanced cycle, A2E
Course title: Master Thesis in Agricultural Science
Course code: EX0486
Program: Agroecology

Place of publication: Alnarp
Year of publication: 2013
Picture cover: Fabian Haro (Potato demonstrative field in Guamote canton, Ecuador)
Title of Series: Självständigt arbete vid LTJ-fakulteten, SLU
Delnummer i serien:
ISSN:
ISBN:
Online publication: http://stud.epsilon.slu.se

Keywords: IPM, Sustainable Livelihoods Approach, potato, pesticides, farmer groups, participation, poverty, livelihood assets, Ecuador

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Foreword

"After all, agricultural research is nothing but a means. The final aim is agriculture and the farmers themselves" Fabian Portilla Rocha, founder of INIAP, 1967.

I approached the Master program in Agroecology almost two years ago with the nagging feeling that what I learnt during my previous university carrier in Italy had not been that useful. I had spent in fact three years of my life trying to remember by heart fertilization formulas and sowing distances, among other useless things. Despite a great degree of effort, what was left after this Bachelor program was nothing but a deep feeling of frustration.

I slowly started to realize that the root of my frustration lied in the fact that agriculture itself, the farmers and their necessities, had been forgotten. In my view, agricultural research was caught in a sort of technology-seeking mania, nourished by too extreme reductionist and positivist philosophical positions. The farmers were not included in the big picture, and what they actually needed was therefore overlooked.

Two years of agroecological readings, farmer meetings and university conferences have turned that feeling of frustration into something very constructive. I have learnt, and I am still learning, that we know enough about the world surrounding us, but we still understand very little. Understanding human beings and their interaction with the environment becomes then a key to create culturally sensitive and socially just food systems.

My experience with the potato farmers in Ecuador was motivated by this conviction. My work aimed at searching for the meaning of their words, with the hope of opening up possibilities for future agricultural research to meet their needs.

Summary

Potato production and consumption play a big role in the central highlands of Ecuador. Two main biotic constraints hinder the development of potato crops on the field: the Late Blight (*Phytophtora infestans*) and the Andean potato Weevil (*Premnotrypes vorax*). The use of agro-chemicals started in Ecuador during the agrarian reform in the sixties, and still nowadays small-scale potato producers customarily apply pesticides to reduce their losses. Overuse/abuse of pesticides in Ecuador represents a threat to human health, to the environment, and a high production cost for some farmers. It can cause the development of pest resistance in crops, and it influences negatively the national food sovereignty. Integrated Pest Management (IPM)has already been proved to be a valid solution to avoid the negativities connected to pesticide use. Yet IPM is not widely employed by potato farmers in Ecuador, and a call for a more holistic IPM evaluation is felt necessary by many actors in the sector.

The overarching objectives of this thesis are 1) to assess in which way the Sustainable Livelihoods Approach could evaluate consequences of IPM potential adoption for Late Blight and Andean potato Weevil and 2) to investigate how this potential adoption could influence the livelihood assets of the farmers part of the IssAndes project. To reach these objectives, five research questions were developed on 1) the perceived change over time regarding farming practices, pest/disease gravity and farming knowledge, 2) current pest/disease management practices, 3) current sources of information on pest/disease management, 4) perception on IPM, 5) the most relevant livelihood assets to evaluate IPM adoption in this specific context.

To address these questions, focus groups, semi-structured interviews and PRA methods were carried out with six farmer groups living in the provinces of Tungurahua, Cotopaxi and Chimborazo. Here potato production and pesticide use add on issues related to poverty and social exclusion of indigenous groups. Moreover, key informants and experts were consulted to acquire deep information about the potato sector.

As it turns out, farmers perceived, during the last three/four decades, an overall simplification of farming practices, an increased attack of pests and diseases, and a progressive loss of farming knowledge. They nowadays apply many different chemical inputs, that ranges from slightly to very toxic. They acquire information about pest/disease management using formal and informal networks, and they value more positively information coming from other farmers, and from technicians during demonstrative harvests/sowings. Respondents knew only few IPM methods, but they showed a big interest in implementing new technologies that could eventually lower the amount of pesticides they spray; they would do it mainly 1) for the health hazards related to pesticide use, 2) for the high cost of pesticides, 3) and to preserve their natural resource base. The human (i.e. decision making capacity and farming knowledge)and social (i.e. networking capacity)assets resulted to be most significant to evaluate IPM in this specific context.

IPM adoption carried out with participatory approaches could trigger experiential learning processes among farmers, enabling them to create valuable local knowledge, thus increasing their access to the human asset. It could also engage them to participate in common activities, creating trust between different communities, thus helping them to expand their networks, and increasing their access to the social asset. This process would have as a livelihood outcome to reduce the vulnerability felt by some farmers towards increasing pest/disease gravity, and the social exclusion experienced by some groups, particularly indigenous.

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Glossary of Spanish and Kichwa terminology

Campesino/s	Smallholder, peasant farmer
Canton/es	Territorial/administrative division
Chakra	Plot
Costa	Lowlands facing the Pacific Ocean
Hacienda/s	Large landholding or plantation originally awarded to ex-colonizers or Catholic subjects
Mercado mayorista	Wholesale market
Mestizo/s	Person of mixed Native American and Spanish origins
Oriente	Lowlands on the east part of Ecuador
Paramo	Wet mountain environment typical of the Andes highlands
Parroquia/s	Territorial/administrative division
Patron/es	Owner of the *hacienda*
Precarista/s	Informal worker or producer that exist outside the currency economy
Sucre	Ecuadorian national currency up to the dollarization in 2001
Sierra	Mountain region or highlands
Wachu rozado	Pre-colombian reduced tillage used in potato production
Wasipungero/s	Servant on the hacienda
Wasipungo	Settlement of *wasipungeros* located on the hacienda

Acronyms

CEPAL	*Comisión Económica para América Latina y el Caribe* . United Nations Economic Commission for Latin America and the Caribbean
CGIAR	Consultative Group on International Agricultural Research
CIP	*Centro Internacional de la Papa*. International Potato Center
CONPAPA	*Consorcio de productores de papa*. Small-scale potato producers association
CST	Critical Systems Thinking
DFID	Department for International Development
FAO	Food and Agriculture Organization
GAPC	*Gobierno Autonomo Provincial de Chimborazo*. Autonomous Provincial Government of Chimborazo
GDP	Gross Domestic Product
IERAC	*Instituto Ecuatoriano de Reforma Agraria y Colonización.* Ecuadorian Institute for Agriarian Reform and Colonization Law
IFAD	International Fund for Agricultural Development
INEC	Instituto Nacional de Estadistica y Censio. National Census ans Statistics Institute
INIAP	*Insituto Nacional Autonomo de Investigacion Agropecuaria.* National Institute of Agricultural Research
IPM	Integrated Pest Management
IssAndes	Innovation for food Security and Sovereignty in the Andean region
MAG	*Ministerio de Agricoltura y Ganaderia.* Ministry of Agriculture
OFIAGRO	*Oficina para Estudios del Agro Cía. Ltda.* Consultancy for Agriculural Studies
PMCA	Participatory Market Chain Approach
PRA	Participatory Rural/relaxed Appraisal
SICA	*Servicio de Informacion Agropecuaria*. Information Service in Agriculture
SL	Sustainable Livelihoods
SST	Soft Systems Thinking
UPA	*Unidad Productiva Agricola*. Agricultural Production Unit

1 INTRODUCTION

Potato production and consumption have nowadays a big role in the highlands of Ecuador. Potato represents a cash crop and staple food for many small/medium scale farmers in rural areas, and an important source of nutrition for many people living in the cities (Devaux *et al.*, 2010). Potato cultivation is hampered by many abiotic (e.g. drought, frost) and biotic constraints. The two main biotic constraints in Ecuador are the late blight (*Phytophtora infestans*) and the Andean potato weevil (*Premnotrypes vorax*) (Kromann *et al.*, 2011; Kroschel *et al.*, 2009; Oyarzun *et al.*, 2005). The overuse/abuse of chemical inputs to manage these biotic constraints is still a big issue in potato production in Ecuador (Kromann *et al.*, 2011; Yanggen *et al.*, 2004; Crissman *et al.*, 2002). Farmers spray many times per year, and many products that are banned in Europe or Canada are still freely applied in Ecuador (Orozco *et al.*, 2009; Cole *et al.*, 2002).

The indiscriminate use of pesticides has had many negative effects on the potato farmers. The extensive use of highly toxic fungicides and insecticides poses a threat to human health, causing dermatitis, conjunctivitis and associated skin problems (Cole *et al.*, 1997b), suspected reproductive and mutagenic effects (Paz-y-Mino *et al.*, 2002; Restrepo *et al.*, 1990), and neurobehavioral disorders (Cole *et al.*, 1997a; Crissman *et al.*, 1994). Pesticides can promote the development of pest resistance in crops (Oyarzún *et al.*, 2002; Lee & Espinosa, 1998), bringing many farmers to increase the amounts sprayed, thus triggering a dangerous positive feedback. Moreover, pesticides represent a high production cost (Devaux *et al.*, 2010), and thereby have influence over what to grow, how to grow it, where to grow it, and for whom (Rosero *et al.*, 2010).

With time alternatives to pesticides use have started to emerge. Integrated pest management (IPM)is practiced in Ecuador and in the Andes region and has already been proved to be a valid approach to sustain the resilience of agro-ecosystems (Kroschel *et al.*, 2012), to reduce environmental hazards (Kromann *et al.*, 2011; Paullan, 2009), and to be economically viable and human health sensitive (Sherwood *et al.*, 2005; Stoorvogel *et al.*, 2004; Cole *et al.*, 2002). However IPM is still not a widespread farmer approach to handle pests and diseases, i.e. most farmers rely heavily on pesticides. A more holistic way to evaluate the benefits produced by IPM adoption has been requested to move forward (FAO, 2006; Riha *et al.*, 1996). This thesis is an attempt for such a more holistic view of IPM adoption.

In the Ecuadorian central provinces of Tungurahua, Cotopaxi and Chimborazo, potato production and the irrational use of agro-chemicals, particularly the abuse of highly toxic pesticides, add to issues related to poverty (i.e. the impossibility for households to satisfy certain basic needs due to a lack of income) and social exclusion (especially of indigenous communities)within the rural population (CIP, 2011; Chiriboga & Wallis, 2010; Chisaguano, 2006). The area is part of a potato and IPM project called IssAndes (a partnership program hosted by the International Potato Center (CIP). This thesis has studied small scale potato producers part of the IssAndes project, in order to explore how potential IPM adoption can be improved, focusing on the integrated way farmers organize their livelihoods.

The evaluation has been done using the Sustainable Livelihoods Approach, a conceptual tool committed to poverty eradication. The approach tries to understand the complexity of people's lives by introducing the concept of livelihood, a broad term that refers generally to the means for securing the necessities of life (Pain, 2012).

2 BACKGROUND INFORMATION

2.1 COUNTRY PROFILE

Ecuador is a South-American country situated in the north-west part of the continent, facing the Pacific Ocean on the west, bordering Colombia on the northern part, and Peru on the eastern and southern side. The country also includes the Galapagos Islands in the Pacific. Although its relatively limited surface (283 560 km^2 (FAO, 2012c)), Ecuador presents a remarkable geographical and ecological diversity, which is reflected also in many socio-economic and cultural characteristics. This diversity is mainly due to the division created by the presence of the Andes that run in direction north south and divide the country into three main zones: the *Costa*, the western lowlands facing the ocean, the *Sierra*, the central highlands that are part of the Andes mountain range, and the *Oriente*, the eastern part of the country where the Amazonian forest starts. Temperatures in the *Costa* and in the *Oriente* are usually hot and humid, whereas in the *Sierra* temperatures are much cooler, although depending a lot on the altitude (FAO, 2012c). Different ecological zones can be found within the country: tropical moist deciduous forest, tropical rainforest, and dry tropical forest on the *Costa*, tropical mountain on the *Sierra*, and tropical rainforest in the *Oriente* (FAO, 2010; FAO, 2001).

Ecuador's population has steadily increased and reached 14'483.499 people in 2012 (INEC, 2011a). The majority of the population lives in the *Sierra* and in the west part of the country. The rural population is around 4.729.000, with an agricultural population of 2.796.000 people, of which less than half is economically active in agriculture (1.219.000) (FAO, 2011). The country has, as many others in the world, undergone a dramatic process of urbanization, with a urban population that has sixfolded during the last 50 years (FAO, 2011).

Economic indicators, i.e. GDP per capita, show that the production and consumption in Ecuador, i.e. economic exchange, have remained lower than in other western countries (Figure 1). During the late 1990s Ecuador went through a period of hyperinflation, defaulting on its on debt, while the entire banking system was collapsing. The government abandoned the currency *Sucre* and replaced it by the US dollar in 2001, stabilizing the overall economy but creating monetary dependency towards the USA (Gray, [s.a.]; Shimizu, 2003). The country underwent a period of economic growth between 2002 and 2012, and it is emerging now as a middle income country, but with pockets of extreme poverty and inequality (CEPAL, 2013a; CEPAL, 2013b).

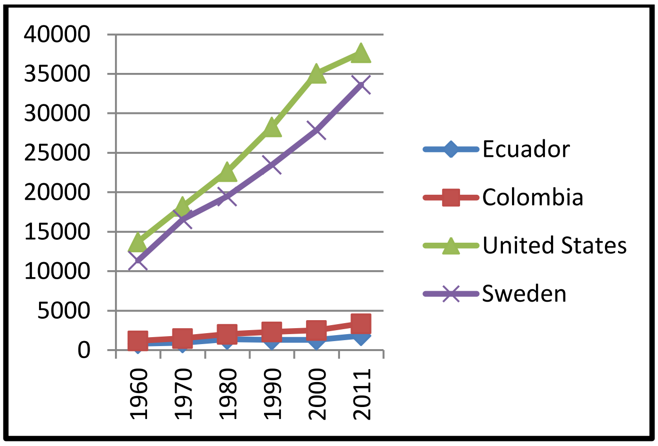

Figure 1: GDP per capita trend in four different countries since 1960 (constant 2000 US$)(Elaboration from World Bank (2013))

What is generally considered poverty (lower incomes and restricted or denied access to basic services like health, education and sanitation) is affecting around 40% of the population, while extreme poverty around 16%. Most poverty and extreme poverty are found in rural areas of the *Sierra* (Chimborazo, Cotopaxi, Bolivar), in the *Oriente*, and in some coastal provinces (Esmeraldas, Los Rios and Manabi). In general, rural areas suffer more of poverty and extreme poverty, and indigenous and afro-Ecuadorian people represent the most indigent groups in the country (CEPAL, 2011; IFAD, 2009).

2.2 BRIEF HISTORY OF THE ECUADORIAN AGRICULTURAL SECTOR

One the most important events in the recent history of the Ecuadorian agricultural sector was the agrarian reform signed in 1964.

Before that, the entire sector revolved around the so called "*hacienda*"[1] system, entailing large proportions of the land owned by few people, the *patrones*. The *patrones* were descendants of Spanish colonizers who gave tributes to the Spanish crown and therefore received land as a payment; on the other hand, the indigenous people to which the land had been expropriated, became servants on the *hacienda,* as *wasipungeros* [2], or *precaristas* [3]. The payment arrangements between owners and workers were mostly of a non-commoditized type, with the worker's salary converted into access to land, water and other resources, sharecropping and harvest percentages. The *hacienda* system has been described as highly exploitative towards the indigenous families indentured in the *hacienda*. (Paredes, 2010; Sherwood, 2009)

The general reaction towards the workers' situation was favored by events such as the Russian and the Mexican revolution, as well as the peasantry revolution in Cuba in 1959, and this contributed into a shift in the public opinion concerning the exploitation of indigenous people. The public support to this issue developed particularly during the '50s, when several studies demonstrated a much clearer

[1] The term refers to a large farm

[2] *Wasipungero* is a *Kichwa* word referring to the servant of the *hacienda.* In exchange for labor, *wasipungeros* were given access to a plot of land to cultivate for their own food needs, the *wasipungo.* They had the right to also reside on this settlement.

[3] *Precaristas* were part of the informal labor sector, landless peasants that were paid in specie (e.g. part of the harvest) and were outside of the currency economy.

degree of inequality in land distribution and the severity of the *wasipungero/precarista* situation (Blankstein & Zuvekas, 1973). Moreover, social malcontent among the lower classes grew as the rate of unemployment increased in the *wasipungo* sector and in the outskirts of the cities. (Paredes, 2010; Sherwood, 2009)

Together with these aspects of social justice, other factors fostered the agrarian reform in 1964. Ecuadorian agriculture was generally considered as "backward", meaning that the level of technology was insufficient, and institutions like CEPAL[4] considered the modernization of the state as an "obligatory passage point" (Paredes, 2010). The idea was to create medium-size farms that could compete freely in a market economy and that these farms should be managed with modern technology and with paid laborers (Paredes, 2010; Eguren, 2006).

The country therefore aimed at trying to solve the unequal land distribution, while at the same time increasing the level of productivity by helping the farmers to adopt new technologies.

2.2.1 THE AGRARIAN REFORM

The agrarian reform was a long process that started in the '50s, which culminated in the promulgation of the Agrarian Reform and Colonization Law on July 23rd 1964; the process of reforming however continued throughout the sixties and seventies.

Remarkable changes were brought about during this period. The *wasipungero/precarista* system was abolished through the promulgation of some articles: informal relations of payment between workers and owners were banned, and cash currency became the only accepted mean for payment. Consequently, minimum wages were introduced and *wasipungeros* were given access to landownership, extension services and the social security system.

Land was redistributed through two main ways: public **confiscation** of land owned by large holders and **colonization** of new lands, especially in the *Costa* and in the wild *Oriente*. In practice, what happened was that most of the land handed to *wasipungeros* was acquired through colonization. This had the aim to relieve the overcrowded *Sierra* and conquer the Amazonian territories, as well as to please some owners who were against the confiscation (Sherwood, 2009). However, the land given up by *haciendas* and the colonized land tended to be the least fertile areas with questionable potential for productivity. Moreover, the average size of the plots obtained by these new farmers through **confiscation** was well below the expectations (Blankstein & Zuvekas, 1973).

At the same time, farmers were encouraged to intensify their production through an increased access to loans, pesticides, fertilizers and improved seeds. With this also followed that farmers had to enter the market, and increase their cropping, in order to pay back debts (Sherwood, 2009). That shift in agricultural technologies included expert organizations, that had the task to develop and evaluate improved varieties, agrochemicals, new machineries, and then pass the results on to the farmers (an approach often referred to as "Transfer of Technology" (ToT)[5]). Many progressive large holders started working closely with those expert organizations, to test new technologies, often distributing

[4] CEPAL is the United Nations Economic Commission for Latin America and the Caribbean
[5] The Transfer of Technology mode of extension encompasses the movement of technology (i.e. physical assets, know-how, or technical knowledge)from one entity (e.g. a research institution, or a western country)to another entity (e.g. a farm, or a South world country). The transfer is said to be successful if the receiver can effectively utilize the technology, and eventually assimilate it.

products in small towns on behalf of the companies; they also became the “good” example of a productive Ecuadorian modern enterprise (Paredes, 2010).

Technology adoption became fundamental in this modernization discourse, and this idea was reinforced as yields soon increased at some of the large modern *haciendas*. In contrast, the farms that had not implemented the new technologies yet were considered as “primitive” or “backward” (Paredes, 2010). A more or less stable and compact network of policy makers, farmers, entrepreneurs, researchers and students were supporting the introduction of the new technology packages; even actors who were against the agrarian reform in general, had to acknowledge the immediate improvements in terms of production levels brought about by the new technologies . Yet many small scale farmers working on marginal lands did not reach the same high yields and performances; they rather found themselves in a difficult situation of indebtedness (ibid.).

New institutions were created in order to facilitate the implementation of the agrarian reform (Table 1). It is important to note that, after the reform period ended, the Ministry of Agriculture (*MAG)* and the National Institute for Agricultural Research *(INIAP)*, acquired more and more importance as some of the biggest farms started seeing amazing results in productivity (Paredes, 2010; Sherwood, 2009). Farmers lost their role in knowledge creation, became mere beneficiaries of knowledge and technology created at the institutional level, and *wasipungeros* and their descendants continued to work the lands responding to little information received by them from agricultural experts.

Table 1 : New institutions created during the agrarian reform

Institution	Task
National Development Bank (*Banco Nacional del Fomento*)	Providing loans to farmers for agricultural modernization
National Institute for Agricultural Research (*INIAP*)	Creating and validate agricultural knowledge Technology validation and development
Ministry of Agriculture and Livestock (*MAG*)	Technology transfer
Ecuadorian Institute for Agriarian Reform and Colonization Law (*IERAC*)	Land expropriation and colonization Distribution of land to ex-*wasipungeros*

2.3 THE AGRICULTURAL SECTOR AND PESTICIDES USE

The agricultural sector in Ecuador has expanded in the last twenty years, even though its relative importance compared to the total GDP has decreased recently, reaching percentages below 10% of the national GDP (World Bank, 2013; CEPAL, 2011; Devaux *et al.*, 2010).

Some farming systems have a high degree of mechanization and use of technology (e.g. banana and flower production). Unlike what might be expected, modernization and the increase in productivity in many agricultural crops have not resulted generally in an improved situation of malnutrition and poverty in the country (Rosero *et al.*, 2010).

The use of chemical inputs is widespread throughout the country for all kinds of farming systems, both fertilizers and pesticides/herbicides. Ecuador has almost no national pesticide fabrication and therefore completely relies on products imported from abroad. Pesticide use has been increasing constantly during the last few years (Figure 2), reaching 31 200 tons of pesticides imported in 2010

(FAO, 2012b); as well, imports of fertilizers have undergone a dramatic increase during the last decades, with a sudden rise during the mid '90s, and a peak of around 300 000 tons imported in 2010 (Figure 3).

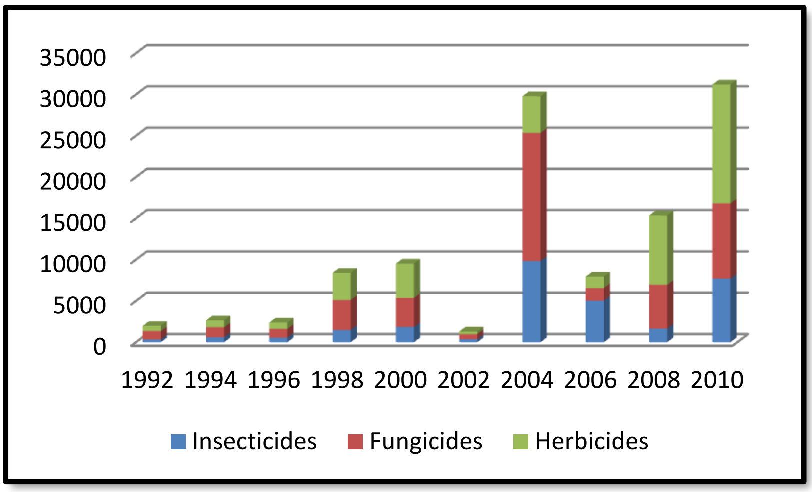

Figure 2 : Use of pesticides in Ecuador since 1992 (tons of product) (Elaboration from FAO (2012b))

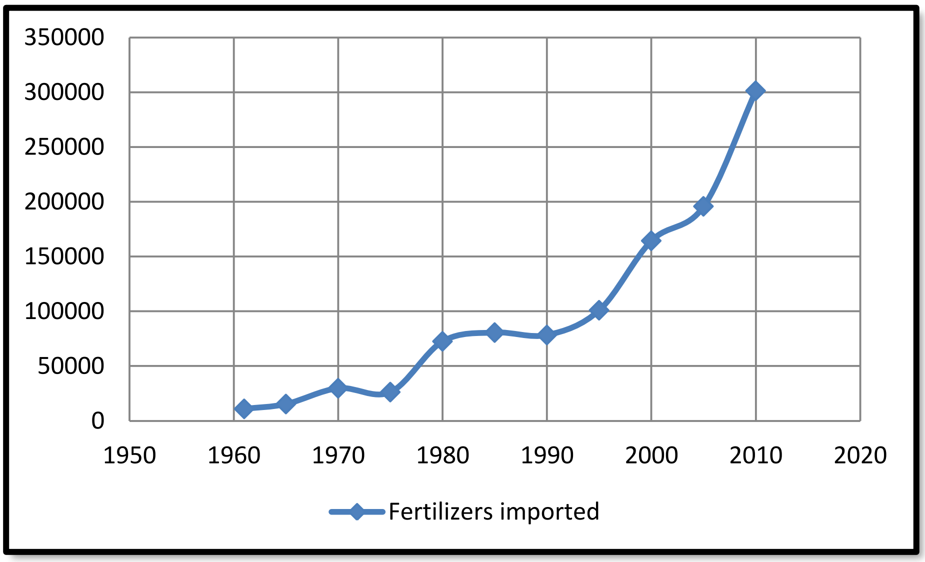

Figure 3 : Imports of fertilizers in Ecuador since 1961 (tons of product) (Elaboration from (FAO, 2012a)

This increasing trend about chemical imports can be explained with the changes that took place in the country after the agrarian reform. It can also be read in the light of the system of subsidies, tax exemptions, and price controls that dominated Ecuador for many years, and that favored the use of agro-chemicals in the country.

Ecuadorian governments in fact have implemented a wide range of policies aimed at promoting the use of pesticides among farmers. Both *price* factors (e.g. direct subsidies, exemption or reduction of import tariffs, reduction of tariffs for selling and excises, governmental programs supporting research, monitoring etc.) and *non-price* factors (i.e. a common underlying bias towards chemical control and a lack of attention for alternatives like IPM), have been employed in order to increase the use of chemical pesticides (Lee & Espinosa, 1998). These policies have had the consequence to reduce both *economic* and *information related* costs for farmers. Lower economic costs means that it is cheaper for the growers to employ pesticides, compared to other pest/disease control methods; reduced information related costs instead prompt farmers to use pesticides through the greater availability of information regarding agro-chemicals (ibid.).

In some parts of Ecuador, the most highly toxic compounds are the cheapest on the market. This is largely because the patents on these early generation products have expired, permitting free access to chemical formulas and competition (Sherwood *et al.*, 2005).

Although Ecuador in the beginning of the '90s went through a period of market-oriented macroeconomic policies that reduced the overall amount of subsidies, exemption and low tariffs, the imports of pesticides did not decrease. This is probably due to the fact that farmers have become accustomed to the use of chemical treatments instead of implementing alternatives, and also because pests and diseases had developed resistances, thus demanding more spraying (Oyarzún *et al.*, 2002; Lee & Espinosa, 1998).

2.4 THE POTATO SECTOR

Potato (*Solanum spp*) is a millenary crop that nowadays plays an important worldwide role in food production. The highest genetic diversity of cultivated and wild potato is found in the Andean highlands of South America, where its centre of domestication lies (around the Titicaca Lake at the border between Peru and Bolivia)(Andrade *et al.*, 2002). Of around 5000 potato varieties in the world, roughly 400 have been identified in Ecuador, however of these only 30 are commonly sown by farmers (Reinoso, [s.a.]; Andrade *et al.*, 2002).

Potato represents one of the most produced and consumed agricultural products in Ecuador, and especially in the *Sierra* region. The potato sector contributes to 6,3% of the total agricultural GDP, which in turn represents around 7,4% of the national GDP (Devaux *et al.*, 2010). The area cultivated with potatoes in Ecuador have decreased over the last 10 years by -1,62%, and reached 43 605 hectares in 2011 (roughly 0,4% of the total cultivated area in Ecuador) (INEC, 2011b). Despite a decreased area harvested, the total potato production in the same period has increased by 5,23%, reaching 339 038 000 tons in 2011 (ibid.). The reduction of area for potato production is mainly due to difficulties linked with the increasing costs of inputs and labor force, and potato fluctuating prices, together with the insecurity caused by climate change and the threat posed by the volcano Tungurahua, which has been constantly active in the last years (Devaux *et al.*, 2010).

The potato sector in Ecuador employs 88 130 producers, which correspond to around 10% of the agricultural producers in the country (Devaux *et al.*, 2010; INEC, 2000). Moreover, according to the data provided by the project SICA[6]-MAG, 250 000 people are linked to the potato sector all around the country, in direct and indirect activities (Vizuete, 2011). Most of the people working in the sector have low levels of education and are mainly *campesinos*[7] in areas of prevalent poverty.

Small-scale farmers (less than 2 hectares) represent more than 50% of the total Agricultural Production Units (*UPAs*), but they harvest just around 20% of the national area cultivated with

[6] SICA is the Information Service in Agriculture (*Servicio de Informacion Agropecuaria*)
[7] The term refers to a small farm owner or a peasant.

potatoes. The rest of the potato production takes place at medium and big farms, that, on the contrary, have access to most of the land used for potato production (Figure 4). This uneven land distribution is further intensified by problems linked to the unclear legal ownership of some lands, and the concentration of poverty in rural areas (Rosero *et al.*, 2010).

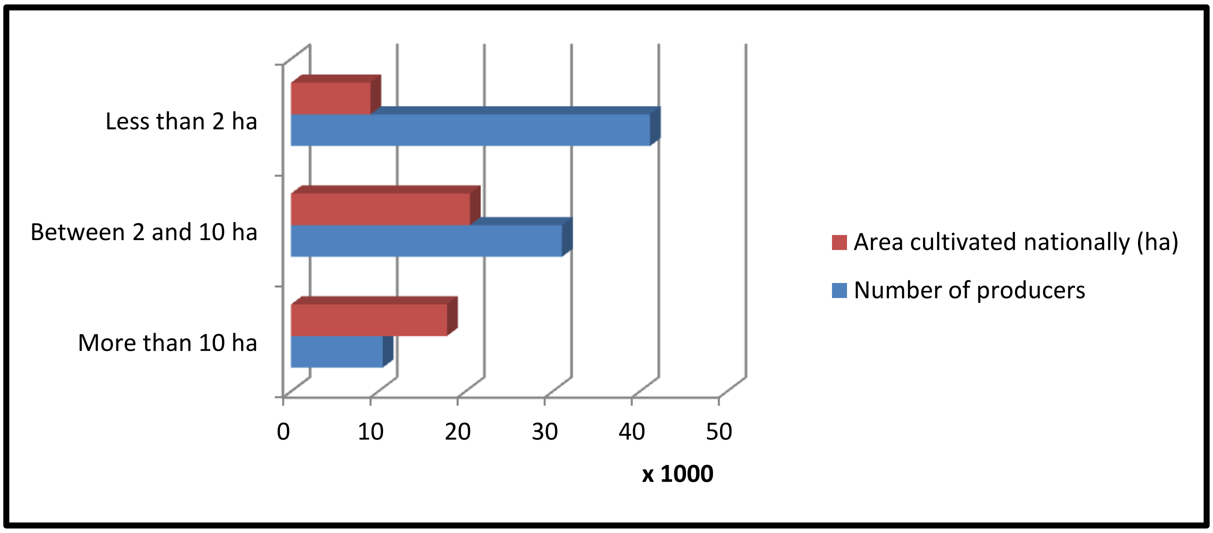

Figure 4 : Relation between farm size and potato area cultivated nationally(Elaboration from Mancero (2007))

The cultivation of potatoes takes place particularly in the central highlands between 2400 and 3800 m.a.s.l., relying on rain-fed cropping systems, sometimes in extremely harsh conditions that allow only potato to be grown (Kromann *et al.*, 2011; Devaux *et al.*, 2009; Andrade *et al.*, 2002). Two main pests and diseases, *Phytophtora infestans* and *Premnotrypes vorax* (See appendix 1), can cause severe yield losses and reduce the tubers' quality (Meinzen-Dick *et al.*, 2009). Farmers control them by using high doses of pesticides and insecticides that in some cases are banned in other countries, and studies made in northern Ecuador shows how producers sprayed up to 7 times with an average of 2,5 products mixed together at each application (Orozco *et al.*, 2009; Crissman *et al.*, 2002; Crissman *et al.*, 1994). Yet farmers still lose remarkable percentages of their crops mainly due to climatic events (frost and drought first of all), but also due to pests and diseases: according to the 3rd national agricultural census (INEC, 2000), 1 478 hectares of potato cultivation failed due to pests and diseases, equal to 3,4% of the area cultivate with potato.

Potato prices in Ecuador are highly fluctuating *intra*-annually and *inter*-annually. Within the year, there is a pattern followed in wholesale markets (*mercados mayoristas*), with higher prices in April/May and December. This is closely related to the seasonality of harvesting, since most producers (in the absence of irrigation systems) are dependent on rainfalls. Inter-annually prices fluctuate without following any clear pattern. Furthermore, potato prices that small-scale farmers obtain are generally low, due to a declining demand for certain potato varieties and the competition from large-scale producers. But also due to their poor market arrangements, i.e. poor connection to the market places, limited access to information and low negotiation capacity (Meinzen-Dick *et al.*, 2009).

2.5 THE STUDY AREA

The study presented in this thesis was carried out in three *Sierra* provinces where the IssAndes project works (Chimborazo, Tungurahua and Cotopaxi). These provinces lie south of Quito, in the most central part of the Andes, as shown on the map (Figure 5). Each province has a capital town: *Riobamba* is the capital of Chimborazo, *Ambato* of Tungurahua, and *Latacunga* of Cotopaxi. A province is divided into cantons, and each canton (*canton*) is then subdivided into parishes (*parroquias*).

Figure 5: Map of Ecuador divided into provinces (Picture from Conn (2007))

2.5.1 CLIMATE

Climatologically the three provinces are quite homogenous. The extreme agro-ecological differences found in this part of the Andes (also within the same province) cannot be attributed to latitude, but rather to altitude (Andrade *et al.*, 2002). Thus differences in altitude determine differentiations in rainfalls, temperatures, rainy periods and other agro-ecological parameters. The area can be divided into three agro-ecological zones depending on the altitude: the Andean zone (more than 3 600 m.a.s.l.), the sub-Andean zone (between 3 200 and 3 600 m.a.s.l.), and the inter-Andean zone (2 800 and 3 200 m.a.s.l.). The zones have different crops cultivated, animals raised, and risks of crop loss (Andrade *et al.*, 2002). Precipitations, in this part of the Sierra, follow a bimodal pattern: from February to May and from October to December (Andrade *et al.*, 2002). Solar radiation is high and constant throughout the year and this affects positively the productive process.

2.5.2 POLITICAL AND SOCIAL ORGANIZATION

Politically, each province is governed by a provincial council (*Gobierno Autonomo Decentralizado-GAD*), that has, among other tasks, the responsibility for environmental protection, watershed management and irrigation works, agricultural promotion, and the provincial road system maintenance and development (GAPC, 2008).

A great degree of the population living in the *Sierra* is considered to have indigenous origin[8]. Around 71% of the Ecuadorian indigenous population lives in the *Sierra*. Around 18,5% of them live in the Chimborazo province, 11,5% in Pichincha, 10,5% in Imbabura, 10,1% in Cotopaxi and 7,9% in Tungurahua. In each province, the indigenous population is a minority, respectively 38% in Chimborazo, 24% in Cotopaxi and 15% in Tungurahua. Around 85% of the indigenous people live in rural areas, often in remote places that lie at a high altitude: in Cotopaxi, for instance, 96,5% live outside of urban areas, followed by Chimborazo (95%) and Tungurahua (92,9%). They often have agriculture as an important source of income and food (Chisaguano, 2006).

According to Chiriboga and Wallis (2010), poverty concerns to a greater extent both rural areas and indigenous groups. Almost 70% of the indigenous people are poor in relation to their consumption habits [9] (Table 2).

Table 2 : Incidence of consumption poverty among different social groups in Ecuador (Elaboration from Chiriboga and Wallis (2010))

Social group	Incidence
Indigenous	69,90%
Afro-Ecuadorian	48,44%
Mestizos[10]	34,37%
White	33,11%
National	38,30%

Moreover, *paramo*[11] areas in the *Sierra* suffer high social deterioration due to poverty, especially in the province of Chimborazo. Tungurahua, on the contrary, has higher socio-economic standards and less poverty if compared to Chimborazo and Cotopaxi. There is a considerable presence of small and medium agricultural productive units, extended irrigation systems, a growing sector of non-agricultural enterprises (tourism first of all), several actions taken by both local institutions and civil society, and a high quality road system (Larrea, 2008).

2.5.3 POTATO CULTIVATION

The cultivation of potatoes in the study area is widespread, and the three provinces represent typical smallholder farming areas in the Ecuadorian highlands (Kromann *et al.*, 2011). The highest number of potato farmers is in fact concentrated in this central region of the *Sierra*. The three provinces have an harvested area of potato that accounts for around 50% of the total area in the country (Reinoso, [s.a.];

[8] The word indigenous refers to the inhabitants of the American continent before the arrival of the European invaders. Descendents of these first inhabitants still live in Ecuador, and they can be distinguished from the rest of the population. They have different cultural practices, clothing, language, relations with nature, community life, and they self-identify as indigenous.

[9] In this case, poverty refers only to the impossibility to satisfy certain needs(e.g. food, housing, transports etc.) through consumption, due to a insufficient level of income. It is also referred to as consumption poverty.

[10] *Mestizos* is a word referring to people who have mixed descent.

[11] *Paramo* is a word referring to an inter-tropical mountain ecosystem. In this case, it is used to identify marginal rural areas at high altitudes, where the concentration of indigenous communities is higher.

Devaux *et al.*, 2010). The production as well is remarkable: 159 366 MT per year, that is 45% of the national total (Reinoso, [s.a.]; INEC, 2011b). After Carchi, those three provinces are the ones with the highest yields in the country (Devaux *et al.*, 2010). Potato production is an activity that interests many people in this area, 55 308 Agricultural Productive Units (UPAs), and represents a primary source of income (especially Chimborazo and Tungurahua) and food for most of the farmers (Meinzen-Dick *et al.*, 2009; INEC, 2000).

Agro-chemicals are widely employed in the study area, and they represent a high production cost for many producers. In the province of Tungurahua, for instance, farmers on average invest 2 035,70 $/ha, of which around 42% is spent to buy fertilizers, insecticides, fungicides and other chemical compounds (Devaux *et al.*, 2010).

In the study area a mix of native and improved varieties can be found. Native varieties are the result of centuries of domestication, selection and conservation, a legacy left by producers from the Andes. Besides a higher content in nutrients and generally preferable taste compared to improved ones, they represent a huge genetic base, they adapt to many different environmental conditions and represent also a good instrument capable of retaining cultural values (Devaux, 2012; Monteros *et al.*, 2005). Improved varieties have been developed by research institutions like INIAP or CIP. They have a more standardized shape and color, a higher potential production, and some of them have been bred to resist some specific diseases (Monteros *et al.*, 2005; Andrade *et al.*, 2002). After the Green Revolution[12], in Ecuador native varieties have been replaced almost completely by improved varieties (Devaux *et al.*, 2009).

2.5.4 THE FARMER GROUPS

The farmer groups visited live in six communities situated in the three provinces where the IssAndes project works (Chimborazo, Cotopaxi and Tungurahua). The communities lie at different altitudes and they present different growing and social conditions (Table 3).

[12] The Green Revolution refers to a series of technology transfer, research and development initiatives, that took place between the end of the 1940s and the 1970s. Together with a widespread use of chemical inputs, machineries and high-breed varieties, agricultural outputs increased in some countries.

Table 3 : Characteristics of the six farmer groups involved in the study

Community	Province	Altitude (m.a.s.l.)	Ethnicity	Participation in IssAndes	People involved in the interview	Gender
Emilio Maria Teran (1)	Tungurahua	2667	Mestizos	No	≈20	Mixed (mostly women)
Emilio Maria Teran (2)	Tungurahua	2667	Mestizos	Recently contacted	9	Mixed
Rumipungo	Cotopaxi	3498	Indigenous	No	≈20	Mixed (mostly women)
Sigseloma	Cotopaxi	2600	Indigenous	Yes	7	Only women
Gualipite-Jatunpamba	Chimborazo	3707	Indigenous	Yes	≈30	Mixed (mostly women)
Liglig	Chimborazo	3595	Indigenous	Yes	≈20	Mixed

Four of them are completely indigenous, whilst the other two are made up of *mestizos* families. Half of the groups had already worked within IssAndes for at least one growing season, whereas the other half were approached for the first time when I visited them with my colleagues (these visits aimed at involving them in IssAndes). Farmers that were already part of the IssAndes project had elected a communal allotment and sown some potato varieties delivered by technicians; some had already tried some IPM methods for Weevil and for Late Blight management (See Appendix 2).

2.6 CIP AND THE ISSANDES PROJECT

The research period in Ecuador had as framework, guide and logistical support the project IssAndes (Innovation for food Security and Sovereignty in the Andean region), a partnership program funded by the European Union. The program is run in four different countries in Latin America (Peru, Bolivia, Ecuador and Colombia). It has as main general objective to improve the level of food security among rural people and in sectors of society more affected by impoverishment, trying to reach the first Millennium Development Goal (eradicating extreme poverty and hunger).

In Ecuador IssAndes has interventions in Chimborazo, Cotopaxi and Tungurahua, in areas where the levels of *poverty*, *malnutrition* and *potato cultivation* are highest. One of the goals that the IssAndes project tries to achieve is to diminish the levels of poverty and malnutrition among young children, by delivering improved native varieties, bred for higher content of Fe and Zn. Besides, IssAndes trains farmers in a rational use of agro-chemicals, and tries to achieve a reduction in the use of pesticides applied by farmers for plant protection. Along the years, several technologies have been developed to control the two main biotic constraints (*Phytophtora infestans* and *Premnotrypes vorax*); these methods go under the umbrella of Integrated Pest Management (IPM). For more detailed information, see Appendix 2. Up to December 2012, the goal for IssAndes in Ecuador was to reach 18 communities with an average of 20 families for each community, so that by the end of the project in 2014, it would be possible to interact with 1053 families in 46 communities.

The International Potato Center (*Centro Internacional de la Papa,* CIP) is the institution that hosts IssAndes and is in charge of managing and coordinating the operations; it was also the logistical base for my research period in Ecuador. CIP is an international research institute part of the CGIAR consortium (Consultative Group on International Agricultural Research), an organization made up of 15 centers around the world engaged in food research.

CIP was born in 1971 with the intention of creating a research institute capable of providing valid solutions to the pressing problems of world hunger and poverty. CIP was in charge of developing, testing and evaluating new technologies regarding potato production (fertilizers, pesticides, herbicides, improved varieties and so forth). The birth of CIP and other research centers has to be framed in the events taking place at that time: the Green Revolution was introducing many innovations in agricultural and socio-economic systems all around the world. Already in 1968, after having boosted the Green Revolution through the creation of the International Maize and Wheat Improvement Center and the International Rice Center, the Rockfeller foundation began sponsoring international meetings of agronomists. Two years later members of the foundation started proposing the idea of a worldwide network of agricultural research centers under a permanent secretariat. In 1971 CGIAR was created and by 1983 there were 13 centers in its network, with a combined exceeding budget of 100 000 000 $ (Dowie, 2001). The mission of CIP nowadays is to achieve food security, well being and gender equity for poor people in root and tuber farming and food systems in the developing world, through research and innovation in science, technology, and capacity strengthening.

2.6.1 OTHER INSTITUTIONS INVOLVED IN ISSANDES

Here below is presented a list of institutions that work as partners, together with CIP, in the IssAndes project (Table 4). A Rich Picture elaborated during the research period in Ecuador, regarding the interactions between the various institutions, is presented in the Appendix 3.

Table 4: Partners involved in the IssAndes project (elaboration from CIP (2011))

Territorial partners	Strategic partners
Estrategia "Acción y Nutrición" del Ministerio Coordinador de Desarrollo Social (Intergovernmental program)	Instituto Nacional Autónomo de Investigaciones Agropecuarias (INIAP)(Research institute)
Vision Mundial (Non-governmental organization)	RIMISP (Centro Latinoamericano para el Desarrollo Rural)
	Escuela Politécnica de Chimborazo (ESPOCH)(Public University)
	Fundación Minga para la Acción Rural y la Cooperación (MARCO)(Non-governmental organization)
	OFIAGRO (Oficina para Estudios del Agro Cía. Ltda.) (Private Agricultural Research Consultancy)

3 RESEARCH OBJECTIVES AND QUESTIONS

The overarching research objectives guiding this thesis were:

- To assess in which way the Sustainable Livelihoods Approach could evaluate consequences of IPM potential adoption for Late Blight and Andean potato Weevil;
- To investigate how the potential adoption of these IPM methods could influence the livelihood assets of the farmers part of the IssAndes project;

Based on these objectives, the following key research questions were addressed:

- How do farmers perceive the change over time (from their parents' generation) regarding:
    - Farming practices
    - Pest/Disease gravity
    - Farming knowledge
- How do farmers nowadays manage Late Blight and Andean potato weevil?
- How do farmers nowadays acquire information about pest/disease management?
- What are the farmers' perceptions on the potential adoption of IPM methods?
    - Why would they introduce them?
    - Why cannot they introduce them nowadays?
- Which livelihood assets are more indicative and can be more useful in evaluating the potential adoption of IPM technologies?

4 THE CONCEPTUAL FRAMEWORKS

4.1 THE SUSTAINABLE LIVELIHOODS APPROACH

The research work presented in this thesis has adopted a sustainable livelihoods (SL) approach, a conceptual tool that draws on many decades of changing views regarding poverty. Sustainable livelihoods approaches have been developed since the 1990s to try to grasp the complexity of poor people's life, and to start a significant change in the context of international development projects, with the aim of enhancing progress in poverty elimination (Pain, 2012; Ashley & Carney, 1999). From this approach, many different livelihood frameworks were developed during the years.

According to the Department for International Development (DFID), the SL approach has 6 main principles:

- ✓ **People-centered**: poverty elimination will occur only if external support focuses on what matters to people, if it discerns between different groups of people and works with them congruently with their livelihoods strategies and social environment;
- ✓ **Responsive and participatory**: people themselves must be the key actors of change, identifying and addressing priorities of work;
- ✓ **Multi-level**: goals will be achieved only if action will be taken at many different levels, and constructive communication is built between micro and macro levels;
- ✓ **Conducted in partnership**: both public and private sectors involved;

- ✓ **Sustainable:** the four dimensions (economic, institutional, social and environmental)have to be taken into consideration and a balance between them must be found;
- ✓ **Dynamic:** external support needs to be flexible in responding to changes in people's situations, as livelihood strategies are *per se* dynamic (Carney, 2003).

Moreover, SL approaches must be underpinned by a **commitment to poverty eradication** (ibid.)

4.1.1 APPROACH

The word approach suggests that, although the underlying principles have to be followed, each framework can be used freely, and its usefulness is set by the user. A framework acts as a simple checklist of issues to explore, prompting the investigator to pursue key connections and linkages between the different elements, and mechanistically following it will yield poor results (Pain, 2012; Carney, 2003; Scoones, 1998). Livelihoods frameworks are conceptual tools, a way of thinking about what people actually do in their everyday life (i.e. the constraints and resources of local people's contexts), and they are not intended to describe a reality or a truth. So approach means that there is not *the* livelihood framework, as much as there is not *the* participatory approach.

4.1.2 LIVELIHOODS

Livelihoods are fundamental to conceptualize the whole range of activities that poor people undertake (Adato & Meinzen-Dick, 2002). As Chambers (1997a) puts it, most full-time employees in the North and industrial workers in the South are hedgehogs, with one big idea, one source of livelihood. Most poor people in the South, though, and now more in the North, are foxes. They do not have one source of support, but several, and they maintain a portfolio of activities. Their living is improvised and sustained through their livelihood capabilities, through tangible assets in the form of stores and resources, and through intangible assets in the form of claims and access. This actor oriented approach tries to fully understand this complexity, acknowledging how not-income activities can also play an important part in sustaining a living.

A livelihood in its simplest sense is a *means for securing the necessities of life* (Pain, 2012). In this thesis the concept is developed using two slightly different views on what livelihood means.

> "*Livelihoods are recognized as comprising the assets (natural, physical, financial, social and human, what people basically have), the activities (what people do), and the access to the assets (which is mediated by institutions and social relations), that determine the living gained by an individual or household*" (Pain, 2012; Ellis, 1998).

> "*A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stress and shocks, maintain its capabilities and assets, while not undermining the natural resource base*"(Scoones, 1998; Chambers & Conway, 1991).

The first definition gives more importance to *access*, i.e. the fact that institutions, social relations, policies are fundamental in mediating how people gain access to their resources, and thus how people make a living. In the second definition the focus is more on the idea of capability[13], but especially on

[13] Here capability is regarded as what a person is capable of doing and being. It includes, for instance, to be adequately nourished or comfortably clothed, to live a life without shame or to be able to visit or entertain one's friends.

that of *sustainability*. This thesis paper draws upon both the concepts expressed in the two definitions of livelihood above mentioned.

4.1.3 SUSTAINABILITY

Sustainability is regarded as greatly important if progress in poverty reduction is to be lasting and not fleeting (Ashley & Carney, 1999). Sustainability contains two main dimensions: one, called *social* sustainability, and the second, called *environmental sustainability* (Chambers & Conway, 1991).

Socially sustainable livelihoods are the ones that are able to avoid external negativities (e.g. shocks or trends), that are capable of resisting them or to come back to the initial status after they have occurred (reactive role). Moreover, they are capable to perceive, predict and exploit changes in the external environment, taking advantages of new opportunities in unstable and changing external conditions (proactive role)(Scoones, 1998; Chambers & Conway, 1991).

Environmental sustainability is about the capacity of a livelihood to preserve the natural resource base, both on a local and on a global level, as well-being is closely related to the environment, in terms of health, security, or peace of mind (Baumann, 2002; Chambers, 1997b).

Locally, the challenge is to have sustainable livelihoods with the aim of avoiding depletion of local resources on which rural people heavily rely upon (i.e. salinization and erosion of soils, deforestation, desertification). Livelihoods can in fact contribute positively by making a wiser use of renewable resources like water, soil or trees (Baumann, 2002; Chambers & Conway, 1991).

Globally, attention is paid to issues like pollution, greenhouses gases or global warming that could negatively affect the long-term sustainability of our eco-systems. Here it is important to see how a livelihood activity influences this world-wide processes (Chambers & Conway, 1991).

4.2 THE SUSTAINABLE LIVELIHOODS FRAMEWORK

The framework used during this research is a particular type of livelihoods analysis developed at the Department for International Development (DFID) over a period of several months . It is aimed at providing the user with a good tool for understanding livelihoods, particularly in rural and poor contexts (Figure 6).

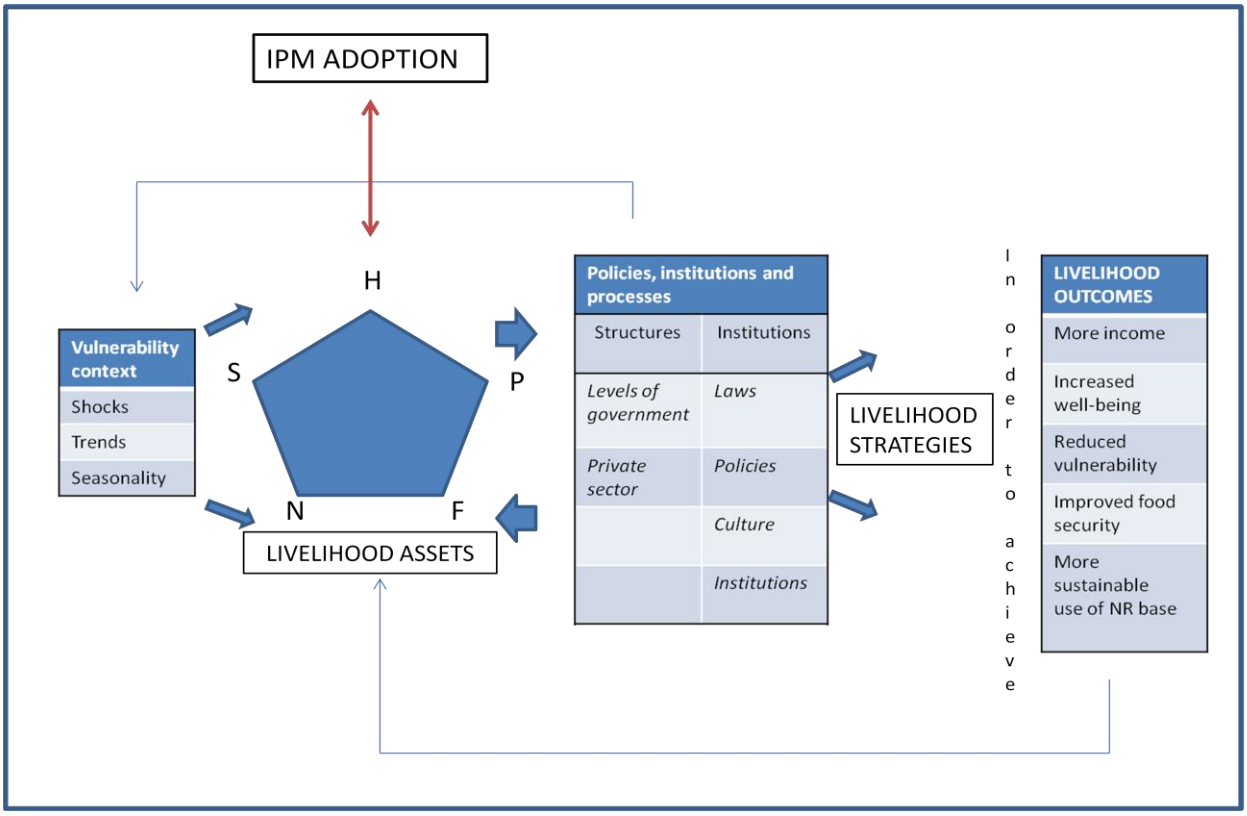

Figure 6 : The sustainable livelihoods conceptual framework, with the role of IPM adoption (Adapted from DFID (1999))

One short way to read the framework would be the following: given a particular *context* (of historical trends, policies, political structures etc.) what combination of livelihood *resources* (what people have, namely livelihood assets) result in the ability of carrying out what combination of livelihood *strategies* (intensification/extensification, migration or diversification) with which *outcomes*? (Scoones, 1998).

4.2.1 THE VULNERABILITY CONTEXT

This section of the framework comprises all the trends, shocks and seasonal shifts that lie outside people's control, but that affect people's livelihoods, and especially the asset pentagon. They in fact are able to destroy people's assets (the resources upon which people rely), but also to create new ones.

Trends encompass changes in population, resources and economic indicators such as prices or technology. Shocks are abrupt shifts like natural disasters, economic crisis, conflicts, whilst seasonality concerns oscillations in prices, employment opportunities or food availability within the year. It is important to note that, in this context, risk is not objective, but it is rather people's subjective assessment of what makes them vulnerable. This is important when they have to make decisions and hence carry out livelihood strategies, like in the case of the adoption of IPM methods (Adato & Meinzen-Dick, 2002).

4.2.2 THE ASSETS PENTAGON

The pentagon represents the resource base upon which people build their livelihoods. This framework highlights five different types of assets. These assets are:

- ✓ Natural asset (land, water , forests, air quality, biodiversity, hydrological cycles, pollution sinks);
- ✓ Physical asset (road, transportation, houses, occupational equipments, technology, energy);
- ✓ Financial asset (cash, savings, credits, remittances, livestock in some cases);
- ✓ Human asset (skills, knowledge, health, nutrition);
- ✓ Social asset (any network that increases trust, ability to work together, access to opportunities, reciprocity, informal safety nets)

Two core concepts in this section of the framework, *substitution* of assets and *trade-offs*, enable to ask strategic questions like: to which extent one type of asset can substitute another in a particular context? Can enhanced human capital substitute a lack of financial capital in certain circumstances?

This part of the framework, both the existence of some assets and the possibility to access them from the households, is influenced by the vulnerability context (shocks, trends and seasonality)and by the institutions, processes and policies described in the next box.

4.2.3 PIP (PROCESSES, INSTITUTIONS AND POLICIES)

This box refers to the formal and informal institutions that condition the pentagon assets and the livelihood strategies carried out by the households. They act at various levels (micro, meso and macro), and one of the objectives of the SL framework is exactly to bridge the gap between the various levels of analysis, and understand how they interact with each other. This section of the framework has also impacts on the vulnerability context (i.e. policies affect trends directly and indirectly, but can also cushion the results of shocks).

4.2.4 LIVELIHOOD STRATEGIES AND OUTCOMES

Livelihood strategy is the general term to define the vast range of activities and choices that people make, subsequently or simultaneously, in order to achieve their livelihood outcomes (e.g. more income, reduced vulnerability, strengthened asset base, increased well-being or self-esteem). Even though the vulnerability context and the institutional processes can play a critical role, the most important factor that determines the success of livelihood strategies is sufficient access to assets (Baumann, 2002).

4.2.5 USE OF THE SL FRAMEWORK IN THIS THESIS

During the research period this framework has been used often to guide the evaluation of the effects of IPM adoption. The DFID framework has represented a “big picture”, providing a long list of issues to analyze. As Adato and Meinzen-Dick (2002) note, not everything on the checklist can be included, and the scope of this study was also to narrow down the focus to would have the highest impact on the communities visited, and also what was most relevant to the important stakeholders.

The focus was in this thesis to analyze how the potential introduction of IPM methods in the six communities affects the access to some assets in the pentagon. The aim was to think holistically about the pentagon, but to focus more on those assets seen as more relevant. The assets have not been quantified, both for a lack of time and tools to do that, and because there was no suggestion in this direction in the literature reviewed (DFID, 1999). The second focus was to see how an increased access to some assets influences the livelihood outcomes of the households.

4.3 AGROECOLOGY

Agroecology is the scientific discipline that provides the ecological principles for how to study, design and manage productive and nature conserving agroecosystems/food systems, capable of being culturally sensitive, socially just and economically viable (Altieri, 1995).

During the research period, a soft agroecological perspective has been employed (Dalgaard *et al.*, 2003). In this sense, Agroecology is used as a trans-discipline, i.e. a field of science that draws on different disciplines and that values and integrates different knowledge systems, not only academic, but also experiential, local and indigenous (Méndez *et al.*, 2013; Ruiz-Rosado, 2006). Besides dealing with biological and agronomic issues, the role of humans and society have been included in this thesis. This approach can also lead to creative breakthroughs, and it helps the researcher to provide more holistic solutions to the problem (Nissani, 1997).

This perspective was adopted with the aim of presenting an integrated view on potato production and pesticide/IPM use, and, in the future, to improve CIP's work of empowering rural people.

4.4 SYSTEMS THINKING

Systems theories and ideas are an integral part of the study and the practice of Agroecology. Systems theories have emerged throughout the 20th century to respond to the increasingly more urgent need to solve interconnected and interdependent problems (Capra, 1996). Formal, positivist/reductionist research methods have been questioned for their capability of dealing with complex problems. This formal rationale has been applied at many scales of analysis, from global organizations to small research centers, and it showed to have only a "partial" success (Gibbon, 2002). More and more it is noticed that analyzing a problem by reducing it to its smallest parts, without having a systemic view, solves one problem while at the same time creating another one (Hofny-Collins, 2006).

The concept of system will be used in this thesis as a *perceived whole whose elements are interconnected* (Ison, 2008). In systems thinking, the whole is not only the sum of its part, but it includes properties, called *emergent*, that single components of the system do not have (Ison, 2008; Hofny-Collins, 2006). *Systems* thinking is a way of interpreting the reality, an epistemological[14] tool to be able to deal with a situation or problem, whereas *systemic* thinking is a term that refers to the special attention given to the interconnections within the system (Eksvärd, 2009; Ison, 2008).

Systems thinking in this thesis has been used from a *soft* and *critical* perspective. Soft systems thinking (SST) is focused on *learning* more than goal, and deals with *issues* and *accommodations*, rather than problems and solutions (Ison, 2008). Human subjectivity in SST is seriously taken into consideration: systems are in fact perceived realities, intellectual constructs of the human mind that help exploring the world. SST has been adopted as it is better suited for circumstances involving humans and many stakeholders with conflicting objectives and perspectives, situations that are not well-defined, with

[14] Epistemology is the branch of philosophy that studies the nature and scope of knowledge.

fuzzy boundaries and subject to change. It is better suited for situations that go beyond the mere analysis of raw data.

Critical systems thinking (CST) includes human subjectivity, but also reflects on issues related to power, conflict and coercion that are always found in social systems. According to CST, the meaning of things is socially constructed and knowledge is created through communicative processes in which people have different power relations (Midgley, 1997). It is then necessary to acknowledge the differences in participation and freedom of debate of different stakeholders. Moreover, CST advocates for stakeholders involvement in the process of making boundaries (Hofny-Collins, 2006; Midgley, 1997). CST has been adopted to better investigate the power that different actors have in the adoption of IPM in the study area. Furthermore, it was used to include the farmers into the process of defining the characteristics of their farming systems, and to make them reflect on the power inequalities that they possibly experienced.

4.5 EXPERIENTIAL LEARNING

Experiential learning theory differs from other schools of thoughts (rational theories or behavioral theories) because it strives to give a holistic integrative perspective on learning that includes experience, perception, behavior and cognition (Kolb, 1984). It offers a fundamental different point of view regarding the process of learning. The process of learning, according to Kolb, has 6 fundamental characteristics:

- ✓ Learning is best conceived as a process, rather than an outcome;
- ✓ Learning is a continuous process grounded in experience;
- ✓ The process of learning requires the resolution of conflicts between opposed modes of adaptation to the world;
- ✓ Learning is a holistic process of adaptation to the world;
- ✓ Learning involves transaction between a person and the environment
- ✓ It creates knowledge (Kolb, 1984).

Kolb's learning cycle (See Appendix 4) is probably the best known model that tries to describe the way people learn. It involves four different steps: concrete experience, reflective observation, abstract conceptualization and active experimentation. A person learns by experiencing something new or that is not part of the ordinary course of events, then reflecting upon it (and this is probably the key part of the process of learning), drawing abstract conclusions out of the first two steps, and finally performing a new, modified action that will bring to a new experience and so on. Kolb's cycle describes a developing process that leads to the creation of new knowledge.

Besides experience, cultural aspects and linguistic issues can also affect the way farmers observe things and perform different actions. Yet the experiential learning model developed by Kolb has been chosen for its capacity of emphasizing the role of practical experiences in the creation of farming knowledge.

The learning process can also be analyzed from the point of view of learning "loops". This approach states there exist three different loops upon which learning is structured. When people, in this case farmers, follow some procedures and rules while trying to correct possible problems, striving to do the right thing, and asking "Are we doing things right?", it is said that the loop is of first order. In double loop learning instead, a person tries to solve the occurring problem by breaking some rules and norms; in this case, a work of reframing is carried out, and the question is usually "Are we doing the right things?", and what is sought is the right way of achieving a result, rather than the right thing. Ultimately, in third loop learning, the fundamental values and principles behind actions are reconsidered and questioned; it entails redesigning the norms regulating single and double loop learning; the question is usually "How do we decide what is right?", and it means that people learn to learn (Hofny-Collins, 2006).

5 METHODOLOGY

5.1 RESEARCH DESIGN

This thesis is the outcome of a qualitative exploratory case study in six communities that were part of the project IssAndes in Chimborazo, Cotopaxi and Tungurahua.

A qualitative approach is often used when little is known about the situation that needs to be studied. Qualitative approaches bring about hunches on what the situation looks like, and particularly on the *processes* that caused the situation to look like this (Gillham, 2000). This kind of enquiry can bring light to issues that otherwise would remain unknown, as it intends to explore the meaning of what people say, how they think and feel about a subject or situation. As Binayak Sen[15] puts it: "*Numbers give one the feeling of facts, qualitative stories give one a feeling of truth*"(Adato & Meinzen-Dick, 2002). Moreover, when there are trade-offs involved in the adoption of a new technology, as in the case of IPM adoption among potato farmers, qualitative methods can give a useful understanding of how different households or individuals value those trade-offs (Gillham, 2000). The focus of the qualitative methods used here has been the search of *meaning*, with the aim of linking the potential adoption of IPM technologies with the consequences on the livelihoods assets of some households.

In the thesis general framework, during the data collection and analysis, a more inductive than deductive mode of reasoning was used. Instead of trying to confirm or reject general propositions through the reading of my data, I tried to identify themes, angles of perception along way, while new information was emerging. The list of research questions represents somehow a chronological sequence of this inductive process.

Field work was carried out between the beginning of November 2012 and the end of January 2013. Six visits, one for each community, were carried out with farmers from the IssAndes project. Around 100 people in the three provinces were involved in the focus groups and in single semi-structured interviews. They were mostly women in four of the six communities included in the study. The age of the respondents varied between fifteen and seventy years old. In three cases (Emilio Maria Teran (2), Gualipite-Jatunpamba and Liglig) a common activity (e.g. a harvest or a sowing) was scheduled in the same day of my interview; in these cases, my conversation with the farmers was then a small part of the day: I had to first follow them during the work, and at the end I could eventually interview them.

[15] Binayak Sen is an Indian pediatrician, public health specialist and activist.

5.2 PRA METHODOLOGY

PRA (Participatory Rural/Relaxed Appraisal) is a participatory approach that aims at enabling local people to share, enhance and analyze their knowledge of life and conditions, to plan and act for future innovations (Chambers, 1994).

According to Pretty (1995), the basic principles of PRA are seeking *diversity*, i.e. including as many stakeholders' perspectives as possible, and encouraging *group learning processes* with both outsiders and insiders involved. These learning processes have the aim of creating *transformation*, i.e. changes that local people regard as improvements. In PRA methodology, the outsider is not an expert, but rather someone who is able to help the stakeholders to define their own objectives and to achieve them (namely a *facilitator*). Changes that have to take place are debated, and therefore actions are agreed among many different conflicting views; this process increases the capacity of people to initiate action on their own (*sustained action*).

The PRA methodology here employed has engaged the stakeholders with an *interactive* kind of participation, where analysis is made jointly to enable locals to take control over local resources, and where participation is a right, not only a mean to achieve research goals (Pretty, 1995). Behind the use of the PRA methodology, there was *communicative* rationality, in which the use of language (also non verbal expressions) is considered fundamental in order to reach shared understanding about goals and plans of action (Groot & Maarleveld, 2000). The type of participation and rationality behind the IssAndes project are different, and this discrepancy has influenced the outcomes of my research.

The PRA methodology has been chosen as it does not only serve the researcher's purpose, but is especially focused on the contribution given to local people, in the form of new knowledge they acquire.

Furthermore, the PRA methodology has been used in this thesis with the underlying purpose of facilitating *sustainable* agriculture. Agricultural sustainability is the emergent property of a soft system, that arises from the interaction of different stakeholders in a specific context (Röling & Wagemakers, 1998). As situations, conditions and knowledge change in time and space, sustainability as well is time and space specific and single farming practices, e.g. an IPM technology, cannot be sustainable by themselves. The process of *innovation* is sustainable, and my investigation has worked to encourage local stakeholders to reflect upon the things they experienced, so as to start group learning processes, leading to increased adaptive capacity and sustainable innovations in the future (Pretty, 1995).

5.2.1 PRA METHODS

Transect walks. This technique has been used twice with key informants, at the beginning of the research period. Although no picture representing the transect walk has been drawn, this tool has represented an entry point into the IssAndes project, the pesticides situation, the relation between farmers and technicians and chemical companies.

Participant observation. Participant observation has been used during the community visits to get close to the people studied, to make the farmers feel comfortable with my presence, and to observe their actions and statements in an everyday context (Bernard, 2006b). As this technique deals with immerging completely in the reality studied (Max-Neef, 2010), work sharing (e.g. collective harvests, potato sowing, trainings and recreational moments) was also part of my research. Participant observation has been carried out throughout the whole period in Ecuador: not only during community meetings, but also when time was spent on my own, in public places or private houses.

Venn diagram. Venn Diagramming has been chosen for its capability of providing valid insights on the way farmers acquire information regarding pesticides use and IPM, and the role of different institutions involved in this process. It has been used as it gives local people a share in the creation and analysis of knowledge, providing a focus for dialogue that can be later modified and extended (Sontheimer *et al.*, 1999; Pretty, 1995). This tool has been used once during my research period, with the community of Gualipite-Jatumpamba.

5.3 INTERVIEWS

Semi structured interviews. In a semi-structured interview one uses a guide for the topics that aimed to be discussed, but leaves a certain degree of freedom to the respondent to follow new directions. (Bernard, 2006a). Semi structured interviews have been used throughout the research period with community members, but also actors in the potato market and experts part of various organizations. The interviews took place outdoors, in the field or in public places (e.g. a square or a football pitch), and lasted between 20 minutes and 1 hour. The language of interaction was Spanish and all the interviews have been recorded and later transcribed; field notes were sporadically taken.

The interview guide (See Appendix 5), used also during the focus groups interviews, was firstly elaborated by studying similar cases. However, during the research period it has been modified several times, as the interaction with the key informants and farmers enriched my understanding of the problem. The interview guide was used as a structure for conversations with the farmers. It helped to remember the topics that were most important and needed to be discussed with them. Many follow-up questions came out during our conversations, especially in focus groups, as the people interviewed brought about other important topics that were not included in the guide.

Key informants interviews. 6 key informants were consulted during the research period. They were colleagues at CIP, INIAP employees, public officers, Vision Mundial and CONPAPA[16] employees. Some of them acted as *gatekeepers,* i.e. they allowed me to have access to information that otherwise would have been really difficult to achieve. During key informants interviews, an interview guide was not used; the respondents were rather free to talk about what they considered important or relevant, and they were interrupted in case of specific questions.

Focus groups. One focus group in each community has been used to elicit collective experience and opinions. This technique deals with gathering a group of people and to start a group discussion about a topic. Members of the group are free to interact with each other and to find their own common understanding of the problem

5.4 DATA ANALYSIS AND PRESENTATION

Data analysis have taken place already during the data collection, while transcription of interviews and typing of field notes were carried out. When all the interviews were transcribed into a word document, main themes, that roughly corresponded to the research questions, were identified across the six

[16] Conpapa is a consortium that promotes the association of small-scale potato producers. It is active in the provinces of Tungurahua, Chimborazo and Bolivar.

community interviews and the key informants conversations. The themes were further analyzed and developed into coherent and successive thoughts. Collecting data and at the same time analyzing them allowed for an iterative process of experiential learning, i.e. helped to modify the interview guide, the order in which the questions had to be presented or the vocal intonation with which they had to be asked.

Data acquired through interviews are presented in the form of quotes. They are used with the aim of illustrating clearly the view of the respondent, but they are paraphrases rather than exact citations. Next to the quote the author is cited, even if the name has been omitted for privacy reasons, and to align the work to some ethical principles that needed to be respected. Permission of the respondents to record the interview was asked.

Results are presented in a combination of text, quotes and tables. Text represents the interpretation of the words of the respondents, whilst quotes are the raw data, what people actually said. . Tables are used to give a better and more direct understanding of what is explained in the text.

5.5 RELIABILITY, VALIDITY OF DATA AND SOURCES OF ERROR

The relatively small amount of single and group interviews, due to the qualitative type of study, do not necessarily represent the voice of the whole community. The results are not supposed to be analyzed statistically, nor to provide a thorough evaluation of IPM adoption within the whole IssAndes project, but rather to improve the understanding of issues brought about by farmers in that specific context.

As some of the study areas are rather inaccessible, each community was visited only once. The selection of the communities was made in line with the IssAndes technicians' visits to the communities. I joined the transport of these project visits and no sampling method was used to choose the communities. Maybe this kind of selection might have had consequences for what kind of information was found (or not found) during the research period.

When the farmers were interviewed about pesticides use, it was not usually specified if the question referred to their private fields, or to the collective plots within the IssAndes project. This means that the results about current pests/diseases management in the six communities comprises not only the IssAndes methods, but also practices that farmers do individually. Few observations at farm level was carried out; thus, the data collected through interviews may in some cases represent common perceptions among the community members interviewed.

6 RESULTS

6.1 PESTICIDES AND IPM: COMPANIES, FARMERS AND INSTITUTIONS

Pesticides companies, through their retailers, are very present in the area, and they promote their products very well. Very often gigantic advertisements along the streets show the newest fertilizers or pesticides. The competition among the companies is getting stronger, as they grow in number. They provide information to growers about what compounds to apply and in which quantity, but their primary purpose still remain to sell as much as possible: this causes often an over-estimation of the amount of products to apply in order to control pests/diseases.

Companies sometimes come to promote their products directly to the fields:

> "*Companies come here to do their promotion…for example, here in this allotment Ecuaquimica* [17]*, and Syngenta* [18] *that provides products to Ecuaquimica, have participated to test and show their products, prior a conversation with us to inform about details of the project…*" Employee of Vision Mundial, November 2012

Farmers have included pesticides in their production schemes since many years. Costs have always been relatively low thanks to national economic policies that favored the adoption of these technologies. Agro-chemicals have therefore represented in the last three to four decades an affordable solution for small-scale farmers in order to control pests and diseases. Today, chemical inputs are regarded as fundamental: their use has accumulated along the years, and they have heavily influenced the way farmers think about their production systems.

Even though some farmers have noticed an increase in pesticide prices in recent years, buying agro-chemicals is still very cheap, and IPM technologies have no chance of competition on a mere short-term economic analysis.

> *"To be more practical, I think that nobody used this method* (IPM) *due to economical reasons, cause here farmers do not produce only to feed themselves, but also for selling. We have lived and we still live of this"* Member of Emilio Maria Teran (1), January 2013

Farmers regard conventional agriculture economically advantageous, mostly because they perceive that yields and consequently revenues are lower with organic production. The communities visited in Emilio Maria Teran, which are best connected to the market, make this point very clearly.

> *"…*(ecological production) *is not convenient economically, as the production is 80%, 50% less than that with chemicals"* Male member of Emilio Maria Teran (1), January 2013

> *"Almost no farmers does that* (agroecological farming practices)*, cause today what is needed is paper money, and nowadays all the farmers do what is easier, more profitable and what takes less work"* Member of Emilio Maria Teran (2), December 2012

[17] Ecuaquimica is the national pesticide company
[18] Syngenta is a large global Swiss specialized chemicals company which markets seeds and pesticides.

Moreover, farmers heavily lack workforce: most male members of the communities have immigrated to the nearby towns, to carry out seasonal jobs (e.g. drivers, construction workers etc), and send part of the money back to their families. Some other community members have started to make handicrafts, clothing or paintings to sell at the tourist markets. In this context, pesticides represent a valid solution to pest/disease management problems. The lack of labor has also pushed many households to stop growing traditional crops (potato, vegetables, Andean grains) and instead they are keeping livestock on high *paramos*, as they require much less work. A general lack of land induces farmers to do less rotation and concentrate more on one crop.

Many studies about IPM and pesticides have been carried out by institutions like CIP during the past few years. Those studies focus mainly on trying to highlight the heavy impacts of pesticides on the environment and on the health of the farmers. IPM represents a valid alternative to avoid these risks, yet application among farmers is still very low. It is felt at CIP that IPM has to be studied from another perspective if it has to succeed; other positive aspects need to be evaluated in order to give IPM more prominence on a national scale.

The picture that results is that the use of chemical inputs in the study area has expanded during the last decades. Favorable trends in pesticides prices and a positive institutional attitude to new technologies have made the farmers accustomed to the idea of including them in their crop systems. Companies profit from this situation and try to push the process even further. On the other hand, some institutions, including CIP, are trying to invert this trend providing information, support and trainings to farmers that are interested in a change; they also strive to find other ways to evaluate IPM in order to give it more importance in the eyes of the government.

6.2 PERCEPTION OF CHANGE OVER TIME

Many farmers remembered that most of the farming practices were radically different compared to the ones they use nowadays. First of all, as expressed by a member from Emilio Maria Teran (2), intercropping was much more frequent and crop residues were always incorporated into the soil:

> *"Inside the fruit rows, we used to sow maize, beans and ocas* (*Oxalis Tuberosa*)*, in the same plot"* Male member of the Emilio Maria Teran (2)community, December 2012

> "*My father used to tell me that the biggest mistake is to sell corn residues: some have to be given to the animals, and what is left has to be reincorporated. This is life for the soil*" Male member of the Emilio Maria Teran (2) community, December 2012

Traditional measures to control pests used to be customarily practiced by farmers belonging to the older generation.

> "*My parents told me that when they had problems with the fly* (name not possible to identify), *they used to put ashes on the plant, but we do not do it anymore*" Female member of the Sigseloma community, January 2013

In all the communities visited, local people confirmed that the use of pesticides had undergone a rapid growth around 30 years ago. Before that period (i.e. before mid seventies, beginning of the eighties) farmers did not use chemical inputs at all, for any kind of cultivation, and there were no retailers selling pesticides. The existence of chemical inputs capable of managing pests/diseases was unknown to many.

> "*And we did not spray, neither potatoes, nor maize, nor beans, nothing. Everything was natural.*" Male member of the Emilio Maria Teran (2) community, December 2012

> "*Around 1975/80 the first pesticides retailers began to appear, before there were not*" Old male member of the Rumipungo community, January 2013

Some other community members, when asked about the arrival of pesticides, mixed up the use of fertilizers with that of pesticides, and did not differentiate between them. They referred to these two groups of agro-chemicals as if they were the same, and they recalled that they first appeared around 30/40 years ago.

> "*Around 30 years ago, when I was a boy, I sowed potatoes, we used to sow with lamb and pig's manure (…) and no fumigation*" Male member of the Liglig community, January 2013

> "*There was nothing, in these years, 30/40 years ago, neither fertilizers nor agro-chemicals to fumigate. I remember that, when I got married at 21 years old, then fertilizers and all this stuff came*" Old male member of the Gualipite community, January 2013

The genetic base for potato varieties (the number of potato varieties cultivated)used to be much wider. This genetic base, which rendered the agro-ecosystems more various and complex, has almost completely disappeared nowadays. Those old native potato varieties have been replaced by commercial potato varieties (e.g. *Gabriela, Cecilia, Superchola, Natividad, Esperanza* etc.). The old native varieties that local people used to cultivate, together with the ones that are still cultivated, are presented in the table below (Table 5).

Table 5: List of native varieties mentioned by the farmers

	Native varieties cultivated in the past	Native varieties still cultivated
Emilio Maria Teran (1)	-	-
Emilio Maria Teran (2)	-	-
Rumipungo	*Leona Blanca* *Leona Negra* *Calvache* *Coneja*	-
Sigseloma	*Carrizo*	-
Gualipite-Jatunpamba	*Puña* *Turca* *Uvilla* *Cacho* *Mashua* (Name not possible to identify) *Migiucu* (Name not possible to identify) *Chiwila*	*Chiwila*
Liglig	*Puña*	-

	Cayamarco *Uvilla* *Norteña*	

As shown in the table above, a distinction between *mestizos* and indigenous communities could be seen: the latter had a very clear idea of the native varieties their fathers used to grow, whilst the others could not mention any older varieties (some did not even know about their existence). In the conversation with indigenous farmers native varieties were frequently mentioned.

> "*As we are indigenous, we had many different types of potatoes: Puna, Turca, Uvilla, Cacho, Mashua, Migiucu, but we have lost everything (…). Now I have a couple of plants of Chiwila, but it doesn't yield as much as when we sow with chemicals*" Old male member of the Gualipite community, January 2013

> *"Before we had Leona Blanca, Leona Negra, Calvache, Coneja, but we do not have them anymore (…)now there are so many chemicals and potatoes taste bitter"* Old male member of the Rumipungo community, January 2013

Native varieties represented a cultural asset that indigenous communities used to reinforce their identity, and upon which they built their own livelihood strategies.

> "*Native varieties have a cultural value, and reintroducing them would bring back the meaning and the importance they have here*" Employee of Vision Mundial, November 2012

Furthermore, despite the absence of chemical treatments to fight pests/diseases, and a more traditional set of farming practices, producers said that attacks of late blight and potato weevil did not use to be as strong as they are nowadays. They all recalled that the potato weevil, until two decades ago, was not considered something dangerous for the crops, and the damages caused by *Phytophthora infestans* were not as evident and widespread as nowadays. Only one group of farmers explained how they always had experienced problems with late blight, even before the arrival of pesticides.

Farmers described the changes that have taken place during the last 40 years as a long process during which many important farming practices have been lost. They talk nostalgically about their parents' generation, when farming was much easier and less complicated than nowadays. In their words, older generations were not facing as many problems as they themselves do, and they also had a wider array of solutions to keep their agro-ecosystems in balance and thus control pests and diseases. A progressive loss of knowledge has taken place during the past decades. One of them describes this idea as follows:

> "*The past knowledge in agronomy was ancestral (…), and it was much better*" Male member of the Emilio Maria Teran (2) community, December 2012

6.3 CURRENT PEST/DISEASE MANAGEMENT

The farmers interviewed generally made a rather large use of chemical inputs to manage both the Late Blight and the Andean weevil. Farmers acknowledged that without the contribution of pesticides, they would lose the whole harvest, and nothing would be left for them. Some of them made the link between the increasingly higher amount sprayed, and the resistance built by the pest/disease.

> *"The product is accustomed to pesticides, now it is accustomed to fumigation, and there is not fruit anymore without applications."* Female member of the Sigseloma community, January 2013

Farmers apply a wide range of different pesticides and seed treatment products, that go from extremely to slightly toxic. The products sprayed vary depending on the community and the pest/disease considered. For Late blight and Andean potato weevil the most used agro-chemicals are shown in the Table 6.

Table 6: List of active ingredients applied in the six communities under study

LATE BLIGHT	ANDEAN POTATO WEEVIL
Metalaxil	Carbofuran
Dimethomorph	Carboxin (Vitavax)
Cymoxanil (Curzate)	Thiram (Vitavax)
Propineb (Antracol)	Profenofos (Curacron) (to use in the refuge traps)
Mancozeb	Acephate (Orthene)
Clorothanomil (Ridomil)	
Mefenoxam	

Some of these products (for instance Carbofuran), even if officially banned at the national level, can still be found in local retailers. Farmers have access to these products, they can buy them and then spray them on their fields. The reason for this controversial situation is attributed by many to the lack of control regarding these kind of issues. The governmental organs that are supposed to carry out a monitoring and regulatory job do not work efficiently. Furthermore, Carboxin and Thiram are pesticides used for tuber-borne pathogens. Farmers use these fungicides to control an insect problem.

In all the communities visited, the average number of field applications per season (in this case they presumably refer to Late blight) is three/four. All the farmers stated that the gravity of the disease depends on the weather conditions: in very rainy seasons, number of spraying could increase significantly.

> "*Applications depend on the weather, 3-4, but also 8-10 sometimes.*" Male member of the Maria Emilio Teran (2) community, December 2012

Farmers did not apply pesticides "*a calendario*", i.e. following fixed dates without revising if the crop was affected and the gravity of the attack. They adjusted their farming practices to the weather conditions, and consequently to the development of the crop and the disease on the field. This can be considered an IPM farming practice. Some explicitly affirmed that they checked how potatoes were performing, if they presented evident signs of disease attack, and they acted accordingly.

> "*When we go and control the plants in the chakra* (plot)*, we check if there is any kind of pest/disease. If there is late blight, leaves are getting yellow, or stems are turning black. In this case, we need to apply pesticides against it. (…) We do the same for the weevil.*" Old male member of the Gualipite community, January 2013

The farmers in the study area did not know so much about other specific IPM methods. The only method that was often mentioned during the interviews was the refuge traps to manage the Andean potato weevil. Some farmers had heard of this method and were using it, while others did not or had dropped it along the years.

Farmers in Emilio Maria Teran (both groups interviewed) stated that they had not harvested potatoes with problems of weevil, and that they had rarely applied insecticides against it. In Emilio Maria Teran (2) farmers had heard about the refuge traps before, but they are currently not implementing them as they think it is not necessary (the incidence of the pest is quite low). The Rumipungo community had heard about and tried the refuge traps thanks to a technician from the *Universidad Central* in Quito; the farmers stopped using them when the project ended and nobody visited the community anymore. The women in Sigseloma community, even though part of the IssAndes project, did not mention that they knew about the traps. The communities of Gualipite and Liglig knew about the existence of the refuge traps thanks to the project IssAndes, that implemented them in collective fields (Table 7).

Table 7: Incidence of Andean potato weevil attacks and knowledge about refuge traps

	Gravity of the potato weevil attack	Heard of the refuge traps	Current use of refuge traps
Emilio Maria Teran (1)	Low	NO	NO
Emilio Maria Teran (2)	Low	YES	NO
Rumipungo	High	YES	NO
Sigseloma	High	NO	NO
Gualipite-Jatunpamba	High	YES	YES
Liglig	High	YES	YES

6.4 CURRENT SOURCES OF INFORMATION ABOUT PEST/DISEASE MANAGEMENT

Farmers generally denounced a lack of knowledge regarding pesticides use. In some cases, they did not know the name of the products and what kind of pest/disease they fight.

> *"I can't describe what I have used against late blight (…).We have fumigated using what Ecuaquimica sends us (…), sometimes it resists, sometimes not"* Female member of the Sigseloma community, January 2013

Some of the farmers denounced a lack of knowledge regarding methods for storing and handling agro-chemicals. They also lacked knowledge about the level of toxicity of different products, and in which way they affect human health.

> *"Somebody already explained us how to store pesticides, but we do not know for how long, or how we can handle these products"* Male member of the Emilio Maria Teran (2) community, December 2012

> *"The majority of the people, if they enter a shop, are completely inexpert, neither know how to handle pesticides nor have any experience (…) Which is the product that affects one's health? We do not know anything"* Male member of the Emilio Maria Teran (2) community, December 2012

Some farmers, especially in the community of Emilio Maria Teran (2), regarded this absence of information very convenient for the people who make money upon the sale of agro-chemicals (retailers, pesticides companies etc.). Farmers regarded themselves as ignorant, and sellers felt then legitimated to over-estimate the amount of product growers should spray, thus increasing their revenues.

> *"Most of the people go to the retailers, say: "I have this problem", and they answer: "Use this or use that" (…) but this is convenient for them, because we are ignorant (…). It is a medieval system"* Male member of the Emilio Maria Teran (2) community, December 2012

Farmers would like the pesticides companies to come to the fields and train them about pesticides use and storage.

> *"It would be good if the retailers themselves came, to see and train the farmers"* Male member of the Emilio Maria Teran (2)community, December 2012

A member of the Emilio Maria Teran (2)community expressed an idea about the link between lack of knowledge and use of pesticides.

> *"People that know less, spray more"* Male member of the Emilio Maria Teran (2)community, December 2012

The way farmers in the six communities acquire information about pest/disease management, and construct their own farming knowledge is a result of information from a mix of different sources, that can be resumed as follows (Table 8).

Table 8 : Sources of information regarding pest/disease management

Source of information		
Informal networks	*Formal networks*	
Parents' knowledge legacy Other farmers Relatives	NGOs Expert organizations Ministry of Agriculture through Trainings Demonstrative harvests/sowings Manuals	Retailer's advices Package label

Farmers regarded the first two sources of information very significant when they had to build new knowledge about a technology or a pest/disease management method. Informal (e.g. parents, other farmers, friends, relatives etc.) and formal networks (e.g. NGOs, expert organizations etc.) provide information that is valued very positively by farmers. Yet, in the eyes of the farmers, this information has to be transmitted orally, better if accompanied by field demonstrations/trainings; handbooks or manuals are usually overlooked by farmers.

"*Another theme is (…)that regarding technologies in manuals. The farmer is not interested in it. At best what he does is this (*he throws a book on the table*). Even farmers with a higher degree of education do not care. It is more important for them what they hear and see from other farmers, and also what has been demonstrated on the field. They understand and then they replicate it*." Responsible of Conpapa Tungurahua, producers' association, November 2012

The institutions that resulted to be most involved in the spread of information about pest/disease management through trainings are the Ministry of Agriculture, Livestock, Aquaculture and Fishing (MAG), the Ministry of Social Development Coordination (MCDS), the National Institute for Agricultural Research (INIAP), the International Potato Center (CIP) and various local NGOs. Also the *Universidad Central* in Quito has been mentioned once by one community. Pesticides companies and retailers have not been included in the list of institutions that provide or have provided some kind of information in the form of trainings. A Venn Diagramm developed at the community of Gualipite-Jatunpamba is presented in the appendix section (See Appendix 6)

Most members of the 6 communities visited had taken part, at least once, in trainings offered by other organizations than CIP. These had dealt not only with IPM, but also with other topics (Table 9**Errore. L'origine riferimento non è stata trovata.**)

Table 9 : List of trainings offered to the six communities visited

Trainings offered to the communities during the past years	Vegetables cultivation Pesticides storing Seed treatment Organic fertilization Reforestation of high *paramos* Water collection Livestock keeping Textiles Community life Dietary habits

Many of the farmers declared that these trainings had been really helpful, especially when they were given the chance to put in practice what technicians had taught them.

Many community members felt that they needed more training to develop their skills and to learn more about pest/disease management and pesticides use.

"All we need is just a bit of training" Members of the Emilio Maria Teran (2)community, December 2012

Some communities (Emilio Maria Teran (2), Rumipungo and Sigseloma) thought the number of trainings they had received had not been sufficient. They would like to be followed more constantly by technicians, with the scope of developing better skills. During the past years, experts or technicians had visited the communities once, and then they had disappeared for long periods, causing some farmers to abandon the projects.

> "*Will you keep coming here, or will you just disappear? Otherwise people will diminish, instead of increasing*" Male member of the Emilio Maria Teran (1) community, January 2013

Farmers suggested also that the communities should be followed on a weekly base, without skipping the meetings, otherwise some participants would stop attending.

> *"You know that if you skip one day, it fails, they* (the farmers) *do not want to participate anymore. Here you have to come regularly, every Tuesday, (…)and then people will come"* Male member of the Rumipungo community, January 2013

> "*We gather the first and last week of the month, if you change the date, people get tired of it*" Male member of the Emilio Maria Teran (2)community, December 2012

The project IssAndes had been the reason why some communities started to have group meetings. Regular encounters with the project's technicians had enhanced the number of times they met with each other, discussing and exchanging opinions about the crop. The oldest member of the Gualipite community stated that the IssAndes trainings had helped his people a lot, i.e. they had allowed them to gather, to stay together while carrying out some farming practices, and also to experience together many recreational moments (eating, playing...).

> *"Yes, these trainings help us. For instance, now we have understood how to control the weevil, now we know, it has been very good, marvelous. In the past years, this did not happen"* Old male member of Gualipite's community

The possibility of taking part in trainings or being a member of a producers' association is remarkably different between Tungurahua and the other two provinces. In the province of Tungurahua the work of the GAD (*Gobierno Autonomo Decentralizado*) is more effective. Many informants stated that the most important and visible achievement of this mode of operation was the road system found in Tungurahua. Roads have got asphalt coverage almost everywhere, even in the most remote areas; many routes have been widened, allowing also lorries to tread along these highways. The direct consequence for the farmers is that they are closer to the big towns. Their villages can be reached more easily by experts or technicians and they themselves can move faster towards market places, farmers association or expert organizations.

6.5 FARMERS' PERCEPTION OF IPM AND ITS ADOPTION

All the communities visited expressed a big interest in technologies that could help them to reduce the amount of pesticides currently sprayed on potato crops. They responded very positively at the idea of avoiding the use of chemical inputs to manage pests and diseases.

All the community members interviewed put health hazards as the main reason to stop using pesticides. They represent a threat to their own health, the health of their children and to the people living in the surroundings.

> *"Here in Ecuador there are many diseases. Many products are used for potato and tomato cultivation, you put ingredient after ingredient (…) but you are affecting what you eat"* Male member of the Emilio Maria Teran (2) community, December 2012

> *"It would be good* (to spray less pesticides) *because too many chemicals sometimes make our kids become sick"* Female member of the Sigseloma community, January 2013

Farmers considered some of the pesticides very toxic and they would like to avoid using them.

> *"It would be advisable for us to use fungicides that are not that toxic"* Male member of the Emilio Maria Teran (2) community, December 2012

The second reason why many farmers in the six communities would choose to use methods without pesticides is that they represent, together also with chemical fertilizers, a quite important cost in the household economy. What they say is that chemical inputs are getting more expensive and they if possible would like to avoid to spend this money.

> *"Chemical inputs are expensive!"* Male member of Rumipungo, January 2013

> *"Now we have to spend quite a lot"* Female member of Sigseloma, January 2013

Yet some farmers more connected to the market in Emilio Maria Teran (1)felt that reducing the expenditures for pesticides would as well reduce harvests, and in turn revenues. Moreover, there is nothing suggesting that the all the communities visited would be willing to pay extra-costs for implementing IPM technologies.

The third reason why some farmers would be prone to introduce IPM methods is that they could preserve the natural environment around them. Indeed the only community that expressed this thought was the indigenous community of Gualipite-Jatunpamba, through the words of its old member.

> *"When they sow a hectare of land, they fumigate and leave everything on the field. (…)We are screwing the environment (…) we are totally doing damage"* Old member of the Gualipite Jatunpamba community, January 2013

> *"If you cultivate only with chemicals, you are poisoning (…)the fields"* Old member of the Gualipite Jatunpamba community, January 2013

In conclusion, what came out of the six group interviews carried out, was that a mix of reasons had hindered the communities to adopt IPM technologies along the years, or had made some of them give up. First of all, they have lacked economical support to introduce alternatives to pesticides. Secondly, and this is probably the main reason, they have lacked a continuous source of information that could have helped them to build their own learning process.

7 DISCUSSION

7.1 FARMERS AND THE PERCEPTION OF CHANGE OVER TIME

According to the results, potato cultivation has changed remarkably during the last 40 years. Application of intercropping, rotations, and traditional methods against harmful insects was customarily applied in the old generation of farmers. A greater number of crops and potato varieties used to be cultivated. From an agroecological point of view it seems reasonable to assume that this high complexity net was one of the factors that kept the agro-ecosystems in balance, and prevented the explosion of pests and diseases (Gliessman, 2007; Altieri, 1995). Farmers in fact recall that the gravity of pests and diseases attacks was remarkably lower in the old generations, even though the use of pesticides was completely unknown.

Farmers regard the farming knowledge possessed by the older generations (*ancestral*) as much better. In their opinion, this ancestral knowledge allowed their parents to deal with less problems regarding pest/disease management. Farmers then recognize a progressive loss of valuable knowledge occurred during the past decades, that nowadays makes them feel vulnerable in the face of increasing pest/disease attack. This feeling of perceived risk, that leads to a situation of reduced well being, is one of the components of poverty (World Bank, 2001).

This progressive loss of knowledge means less accessible decision making capacity and farming knowledge to perform livelihood strategies. Many farmers denounce that this human asset has progressively been diminished: they cannot count on it anymore when they have to take decisions, or to choose a livelihood strategy. The access to this asset has been diminished since the agrarian reform was initiated: in fact, during that period, the task of producing and validating knowledge was transferred from the farmers, to research institutions like INIAP, MAG and more recently CIP.

Pesticides companies, in the eyes of the farmers, have benefited from their ignorance, as they can sell higher amount of inputs. Having to rely on what the retailers tell them to do, or on what other organizations suggest them, makes the farmers feel quite vulnerable in the face of increasing pest/disease attacks, due to the increased pesticide use and the use of mono-culture.

7.2 FARMERS AND THE CURRENT MANAGEMENT OF PESTS AND DISEASES

In the study area pesticides play a big role in pest/disease management. Nowadays farmers cannot grow potatoes without the use of chemical inputs; applications of hazardous active ingredients to manage the late blight and the Andean potato weevil are widespread, and carried out throughout the growing season. Farmers seem to make a link between the weather conditions, the development of the late blight in the field, and the number of applications/amount of fungicide to spray. This highlights that farmers have gotten a basic notion of disease/ecosystem dynamics through an experiential learning process. Yet they do not know so much about alternatives to chemical inputs, and the only IPM technology that some have heard about is the refuge traps to manage the Andean potato weevil.

Pesticides use appears to have become an essential part of the social and environmental fabric of the region. Some farmers may be part of farming styles in which pesticides came to be accepted, after the agrarian reform, as obligatory or unavoidable elements of good potato farming (Paredes, 2010; Sherwood *et al.*, 2005). The choice of using agro-chemicals (a livelihood strategy)during the last decades has been prompted by what happened within the vulnerability context of the SL framework:

costs of pesticides in Ecuador have been systematically reduced for decades, until the beginning of the 1990s, allowing farmers to have increased access to the financial livelihood asset. The costs farmers had to incur for pest/disease chemical management dropped, together with the costs related to information about these methods. Moreover, less labor was needed on the farm, diversification of livelihood strategies brought many members to emigrate to the cities to do other jobs, and then sending money back to the village. Furthermore, as shown in some interviews, higher yields obtained with the help of chemical inputs represented for some farmers enhanced revenues. Hence, the benefit to yields, lower costs and revenues, brought about by pesticides use, generally exceeded the additional costs of using them[19] (Sherwood *et al.*, 2005). This strategy was adopted to reach more income as a predominant livelihood outcome, but it lacks completely the environmental sustainability aspect inherent in every livelihood.

This decreasing trend in pesticides cost has been highly influenced by some *institutional processes*: during many years non market-oriented policies were applied and subsidies were directed towards agro-chemicals use. More specifically, governmental policies favored directly (e.g. through the use of exemptions, preferential tariffs) or indirectly (a general lack of attention of environmentally friendly alternative like IPM) the adoption of chemical inputs. Research shows that when taxes on pesticides decrease and potato prices increase, the consequence is usually that farmers plant more of their farm with potatoes and tend to use more pesticides per hectare (Sherwood *et al.*, 2005).

7.3 FARMERS AND THE INFORMATION ABOUT PEST/DISEASE MANAGEMENT

As denounced by the farmers, the application of chemical inputs is done without real knowledge about the doses to spray, the ideal number of applications, and the health and environmental hazards. This is due to a lack of necessary institutional support to develop their skills. No farmer reported receiving sensible information about pesticides storing/handling practices from retailers; this is a dynamic that takes place also in other potato farming areas of the country (Espinosa *et al.*, 2002). They attribute to the lack of useful information the reason for their vulnerability to pest/disease attack; as they are afraid of losing part of their harvests, they spray with agro-chemicals as recommended by retailers.

On the other hand, they heavily value and rely on the information received by other farmers or technicians. While other assets are weak, the *social* asset in relation with pest/disease management is very important for these Andean community farmers. The contribution of this informal net in the spread of information is great, and this suggests that the networking capacity (as social asset described in the SL pentagon) becomes then very significant when farmers try out new livelihood strategies. Particularly in indigenous communities, strong institutions regulate the community life through communal landholdings, work obligation and recreational moments (Meinzen-Dick *et al.*, 2009).

Yet, a deeper look at the results and the background information suggests that, while there is strong bonding *social* asset within the community, most of these farmers, especially indigenous ones who do not speak good Spanish (Chimborazo and Cotopaxi), suffer from social exclusion at large in the region. As proved in other farming areas in Ecuador, the current political system largely excludes rural communities from decision-making processes, while at the same time farmers have had limited

[19] Yet this is true only for direct production costs such as inputs or labor, but not for the costs of externalities like human health costs or environmental costs.

experience with the degree of social organization and collective action needed to advocate interests in modern-day political fora (Sherwood *et al.*, 2005). So the networking capacity building potential, embedded in IPM adoption, needs to be directed towards external organizations or outsiders, in order to bring in additional resources or to represent the members' interests outside the community.

For this reason, many farmers would like to receive more trainings by institutions like CIP or the ministry, and to count more on the information received by technicians and other farmers during informal meetings. The IssAndes farmers trainings are in fact regarded as beneficial by the farmers because they represent a good source of new information, and because they allow different people to gather, discuss different ideas, and thereby expand their networks, also outside the community boundaries.

7.4 FARMERS AND THEIR PERCEPTION ON IPM ADOPTION

Many farmers are willing to introduce techniques with low use of chemical inputs. Their interest in IPM shows that they themselves are already realizing that the use of pesticides implies several negative aspects. They would like to avoid these negativities, by using lower amounts of pesticides, by using less dangerous compounds, by being trained about handling/storing/spraying techniques, or through the use of IPM technologies.

The health hazards that pesticide use brings about is the main reason why farmers would start using IPM technologies. They perceive pesticides use as a major risk, and they feel vulnerable towards the emergence of diseases caused by pesticide intoxication.

The second main reason to start using IPM technologies is that pesticides represent a high production cost in the household economy. Yet, as denounced by some farmers (especially the ones more connected to markets), this cost is not enough to justify the adoption of alternative technologies that farmers perceive would possibly diminish the amount of potatoes harvested, and in turn revenues. Evaluating the effects of IPM on the financial asset is therefore easily skewed by some institutional policies, and the result today is that IPM is not really felt to be economically important by the farmers.

7.5 FARMERS AND CULTURE

The use of certain farming practices in the study area has tight links with cultural identity. Culture includes beliefs, traditions, language, identity, festivals or sacred sites (Adato & Meinzen-Dick, 2002). In some of the communities visited, culture was linked, for instance, to how farming practices were carried out in the past, or the relation of certain crops to their ancestors. In the specific case of indigenous communities, the taste and texture of some native potato varieties, as well as the status of "indigenous" that is associated with them, were part of the cultural sphere. Native varieties for indigenous communities represented an important cultural asset, compared to *mestizos*.

These cultural aspects are very relevant when evaluating the consequences of a new technology adoption. They may not have effects on the financial asset (i.e. direct economic benefits), but they are central in people's lives and livelihood strategies (ibid.). Sometimes they may have economic benefits, like in the case of some community members selling handicrafts and paintings at tourist markets. The

SL framework does not include in the asset pentagon an explicit reference to cultural values, even if farmers continuously rely upon them to try new livelihood strategies.

7.6 IPM AND THE LIVELIHOOD ASSETS

What comes out of the results is that farmers feel mainly vulnerable to pests/diseases attacks, due to a low capacity of having access to useful information in order to construct their own knowledge. IPM could be then used for and evaluated as an agent for triggering processes of farmers' collective learning, encouraging communication among them, and in turn strengthening their decision making capacity, farming knowledge and networking capacity. The assets that would be more indicative in this regard would then be the *human* and *social.* They are often undervalued, but they represent important aspects to enable the farmers to have higher pay-offs (Meinzen-Dick *et al.*, 2009). Evaluations of IPM adoption in relation to the *financial* asset are today less useful due to the legacy left by decades of institutional roadblocks towards sustainable practices, and by the lack of interest on the farmers' side as a result. Consequences of IPM adoption on the farmers' *cultural* background would be hindered by the absence of this asset in the SL framework.

7.7 IPM ADOPTION AND THE CONSEQUENCES ON THE HUMAN AND SOCIAL ASSETS

7.7.1 THE HUMAN ASSET

As farmers have not questioned until recently the efficacy of the methods related to agro-chemicals, they have acted for decades on a first loop level of learning. For many years they have been asking themselves questions related to pesticides usage. In other words, which product do I need to buy to manage the late blight and the Andean potato weevil? How many times per season do I have to use this product? How much do I have to increase the amount to apply in relation to the weather conditions? These questions suggest that farmers were not questioning the pesticides method itself, but they rather followed established procedures and corrected possible problems encountered on the way. This can be described as knowledge on the level of "Are we doing things right?".

With the adoption of IPM methods within the IssAndes project, new experiential learning processes could be initiated, enabling farmers to reflect upon the experiences they have, conceptualizing them, to then perform new, modified actions. New local knowledge could be created in such a process, thus reducing the vulnerability felt by many households regarding pest/disease management, increasing the competitive advantage towards larger farmers, and sustaining their actions in a long-term perspective (Thiele & Devaux, 2011; Hallman *et al.*, 2003; Adato & Meinzen-Dick, 2002). This would lead to increased well-being, and eventually to less poverty.

Such an IPM adoption project needs to be carried out using participatory approaches, i.e. training programs aimed at empowering people to solve living problems by fostering participation, self-confidence, dialogue, joint decision-making and self-determination. To allow farmers to set necessities and priorities may lead to innovative and more long-term sustainable solutions and thereby provide a solution to reduce vulnerability and consequently poverty (Adato & Meinzen-Dick, 2002; Röling & Wagemakers, 1998; Pretty, 1995). This would also help the farmers to break some norms and rules, reframing the knowledge they have about pest/disease management, bringing them to the second loop of learning: "Are we doing the right things?".

7.7.2 THE SOCIAL ASSET

IPM trainings within IssAndes could enable farmers to share common experiences, to construct a community together, and to expand their network of contacts within the community and even outside. To implement IPM technologies in the communities that have not tried them yet, and to improve them in the communities that do have, has the potential to carry this process even further. It would allow more people to create contacts with neighboring farmers communities, by making them participate in common activities. It has the potential to create trust between communities in different geographical areas, thus reducing the social exclusion experienced by many, especially indigenous communities (Meinzen-Dick *et al.*, 2009). A strengthened social asset would also represent a necessary factor to facilitate the emergence of future collective action platforms, that in turn would enhance the social asset held by the farmers even more (Devaux *et al.*, 2009). A positive feedback loop could then be started up, leading the farmers to feel more sustained by the surrounding network, and in turn more secured and less vulnerable towards future changes.

Experiences from Germany suggest that strengthened formal and informal networks among farmers, and between farmers and consumers, can also play a crucial role in the development of eco-farming (Gerber & Hoffmann, 1998).

Such stronger connections within the network of potato farmers would have the potential to bounce back to the human asset described above. A more significant networking capacity would increase the level of information exchange among potato growers, thus raising the human asset available in terms of decision making capacity and farming knowledge.

7.7.3 OTHER CONSIDERATIONS

An enhanced level of social and human asset would render that the farmers could identify common interests, share market knowledge, and carry out joint activities to develop new business opportunities. In this regard, they would be also less vulnerable to the unpredictable potato price situation; being united in associations, interacting with important market agents, farmers could find new possible market niches for their products (Devaux *et al.*, 2009; Meinzen-Dick *et al.*, 2009). A better farming knowledge and more stable farming networks would also allow them to choose the most profitable varieties, that are more stable in terms of price, or that have a particular market demand. The participatory market chain approach (PMCA) and the stakeholder platforms, developed during the Papa Andina experience, demonstrate this potential (Devaux *et al.*, 2009). Moreover, in areas closer to the Quito urban market, greener production, as well as a robust distribution system and consumers demand are already a significant part of the food economy (Sherwood *et al.*, 2005). This constitutes an advantage for potato farmers using less pesticides. Such a scenario suggests that increased social and human assets would also affect the situation of the financial asset for many households

As can be noticed in the SL framework (Figure 6), the arrow from IPM to the asset base is pointing in both directions. This suggests that not only the IPM could affect the access to some assets, but also that an increased social asset (e.g. the organized effort of a farmers' network), or a higher/more accessible human asset (e.g. individual farmer experimentation, adaptive or innovative capacity)can have an influence on the way IPM technologies are conceived (Adato & Meinzen-Dick, 2002). Farmers can develop modifications to the IPM methods that better meet their needs of resource-poor growers. This would give the chance to CIP, or other institutions working with IPM, to get a constant feedback on the practical outcomes of the technologies.

A key element in the success of IPM adoption among these farmers is the support given by an effective advisory system. IPM technologies and practices cannot be only bought and applied like pesticides, but need facilitators helping the farmers to understand how the methods work. The response of the potato growers can vary remarkably depending on the presence or absence of qualified IPM advisors, trainers and facilitators (Kroschel *et al.*, 2012). New working positions for pest specialist need to be created, together with inclusive and participative farmer field schools to allow growers to take part in this learning process. This study showed that trust and dedication from specialists, and information brokers, is highly rated by farmers, and that written training materials are ignored by farmers. Participative hands-on training programs with locally trained facilitators, therefore appear to be important farmer training alternatives.

Moreover, the government should undertake measures to declare IPM a national pest control strategy (e.g. enforcing the use of resistant potato varieties against late blight, advertising crop rotation as a meaningful solution against pest attacks, and prohibiting most of the broad spectrum pesticides currently sprayed). More public resources should be directed to such actions, and a sort of IPM subsidization could be a step forward (Röling & Flirt, 1998). The fact that in Ecuador there is nowadays no organized governmental extension service (Meinzen-Dick *et al.*, 2009), and that there is a strong presence of different chemical companies (that take an advantage of the institutional absence in rural areas), is one of the main limiting factors for the introduction of IPM nationally. Ultimately, technology adoption would be favored in those provinces (particularly Tungurahua) where farmers have higher access to roads and transportation (*physical asset*).

7.8 WHAT DID THE SUSTAINABLE LIVELIHOODS (SL) APPROACH ADD TO THE INVESTIGATION?

The idea of SL approach in this research was to use it as a tool to highlight key points and connections that otherwise would have remained hidden. The situation analyzed was characterized by a high level of complexity, and by a high degree of unknown issues. The use of the approach and the SL framework made it possible to handle this complexity, and it suggested specific interrelations to continue to examine in more detail.

In particular, the potential consequences of the IPM adoption on the households have been evaluated using the asset base contained in the framework. Not only income, health or usual indicators have been taken into consideration, but also other assets on which households base their livelihood strategies. The human and social assets that are part of the pentagon have provided an additional perspective on how to assess IPM adoption effects.

The SL approach has constituted a new frame of evaluation of the concept of poverty. It has enabled to think “out of the box”, and to realize that rural people can regard themselves as poor not only for a lack of income, but also for other missing necessities. Providing financial means is sometimes not sufficient to help people to step out of a situation of poverty. The SL approach has put the concept of livelihood at the centre of this research, i.e. a means for securing the necessities of life. This broader term has helped to acknowledge the complexity of potato growers’ lives, and to take into account the whole range of livelihood strategies they use in order to make a living . The SL framework has then represented a checklist to evaluate broadly how IPM adoption would affect their entire asset base, and not only the income level.

The use of the SL approach has also made it possible to highlight the importance of power relations within the context of pesticides use in Ecuador. The links between agro-chemical companies and farmers have been carefully analyzed, showing the part that retailers play in the spread of information about pest/disease management. The benefits for the companies derived from this situation, as well as the disadvantages for the farmers, have been clarified more easily through the use of the approach. By using the SL approach an opportunity was opened up for the interviewed farmers and key informants to talk about power issues that underlie the situation of poverty; they expressed their lack of knowledge and addressed possible reasons for that, as well as understanding for which actors that situation was convenient.

Micro and macro levels of analysis have been connected: macro policies or structures (e.g. the subsidy system created at the governmental level) were put in relation with micro level (e.g. the household and the use of pesticides), and important correlations were highlighted. Moreover, by using the SL approach, links between urban and rural areas became visible (e.g. the rural-urban emigration and the relation to evolving farming practices).

7.9 REFLECTION ON THE LIMITS OF THE SL APPROACH

The use of the SL approach, given its commitment to complexity analysis, can appear sometimes daunting (Adato & Meinzen-Dick, 2002). As Carney (2003) puts it, many users, especially the ones that are new to SL thinking, feel that SL approach sounds appealing, but they do not know "how to do it". It was felt often during the research period that the holistic feature of SL thinking was not making it easy to find an entry point to approach the subject, nor to find special aspects of the potato sector to focus on. Clearer instructions on how to read the conceptual framework would have helped to start earlier the farmers interviews.

Culture is not always explicitly comprised in the SL framework. With the help of a SL framework with more explicit focus on cultural assets, this research would have included the effects of IPM adoption on the cultural asset base, thus evaluating more widely the consequences on the communities visited.

Even though it was possible to analyze power issues, the SL framework can give sometimes a somewhat cleansed, neutral approach to power relations between different stakeholders (Ashley & Carney, 1999). This is in contrast with the big role that power imbalances play in determining poverty in the context of pest/disease management in Ecuador (i.e. agro-chemicals companies' dominance and the lack of knowledge perceived by farmers). Institutional aspects of power could be evaluated using the PIP box, or the social asset, but probably a seventh *political* asset, including for example membership to parties or freedom to speech, would have rendered the SL framework more explicit in terms of power issues.

The framework does not give enough attention to the diverging conditions, assets or livelihood strategies of socially differentiated groups. It was always necessary during the research period to put additional attention of the difference between indigenous and *mestizo* communities.

The SL core idea that people themselves should be the key actors in defining livelihood priorities has been questioned many times during the research period. It was felt that, rather than by the households, the framework was applied by external actors like CIP or myself. The framework itself has never been presented to the people interviewed, and it has been used more as a research tool than as a means for social participation. Even though external actors can play an important facilitating role to bridge what smallholders have and what they need, participation should be more than just a slogan, and take place in every moment of the research process (Meinzen-Dick *et al.*, 2009). Another core idea of the framework, poverty elimination, needed to be tested continuously. As Ashley and Carney (1999)point out, there is not explicit recall to poverty in the framework, and the idea that the use of SL thinking will eliminate poverty had always to be re-evaluated.

7.10 REFLECTION ON THE RESEARCH METHODOLOGY

The qualitative type of study has helped to explore issues that had not been studied before (the consequences of IPM adoption on the human and social assets). The qualitative enquiry was also fundamental to highlight the *process*, that started with the agrarian reform and affected farmers' access to certain livelihood assets (farming knowledge/decision making capacity).

PRA methodology has been helpful to look at the situation from the perspective of those involved in it, to leave apart for a moment the formal objectivity and to dive into more subjective aspects of their farming systems.

As pointed out by Pretty (1995), even a sole researcher can work closely to the communities using PRA methods. Yet the ideal situation is when a group of investigators, having different educative backgrounds, come together to work in participatory projects. By doing this, the researchers can approach the issue from multiple perspectives, monitoring each other's work and carrying out different tasks at the same time. Unfortunately, none of my colleagues in fact were trained in PRA, and the need for a team became evident during the research period, especially for visualization and diagramming methods (e.g. the Venn Diagramm). Due to this, and to some language barriers, it was almost impossible to convince ten or more people to gather around a table, to quickly explain them what the exercise was about, and to make them draw it.

Since PRA methodology encompasses a relaxed appraisal of the situation under study, time becomes a major constrain. During the interviews of key informants and farmers, time was very limited, as the interviewees were often busy in carrying out other tasks. More time available would have allowed a better development of some PRA methods.

Due to these time and human resources constraints, it was not easy to differentiate between different respondents. It was not possible to divide the communities into men and women, or rich and poor, and carry out different group interviews. Particularly in indigenous communities, the respondent was often the oldest male member, i.e. the community leader. After the question was posed, discussions were taking place among the community members, but the final answer was given by the community leader, who was thus acting as a "communication filter". In *mestizos* communities, and in indigenous communities where only women were present, this interview dynamic was not as evident, the interaction between the respondents and myself was more free, and focus groups worked much better.

Due to the same reasons, the findings obtained are not always accurately divided between Late blight and Andean potato weevil. Time did not allow to come back to each single question and ask if the answer was referred to the weevil or to late blight. The farmers' lack of knowledge has also played a part in this confusion.

7.11 RECOMMENDATIONS FOR FURTHER RESEARCH

The study has highlighted that, in order to accomplish a more rational use of pesticides by farmers, CIP and the IssAndes project need to study and get closer to issues regarding regulation and policy-making in the pesticide sector. There is a need for future studies aiming at elucidating national pest/disease management policies oriented towards IPM, and the reduction of the widespread promotion and facilitation of pesticide purchase done by agro-chemical companies. The implementation of IPM methods together with farmer trainings, and the consequent increase of not only the natural assets, but also human/social assets, could then be speeded up. SL thinking suggested that CIP, together with the other institutions that are part of IssAndes, should then undertake policy advocacy activities, to help the promotion of rational use of pesticides and IPM with the aim to increase sustainable livelihoods in rural Ecuador, and to claim changes at governmental levels.

The study also pointed out the farmers' claim for a safer use of pesticides, and for the ban of the most toxic ones. As farmers are afraid of health complications linked with pesticides use, further research should concentrate more on these issues, assessing pesticides hazards and IPM overall health benefits, and establishing lasting solutions with the inclusion of the farmers in the learning process. The model to follow would then be the project *EcoSalud*, developed by CIP and other institutions in the *Carchi* province during the 1990s (Sherwood *et al.*, 2005).

8 CONCLUSIONS

Much emphasis in agriculture and technology adoption is put on usual indicators like income, health indexes and environmental indicators. This study demonstrated how the IPM adoption among small-scale farmers in central Ecuador could be evaluated more holistically using the Sustainable Livelihoods Approach.

The agrarian reform, with accompanied pesticides favoring policies, has considerably increased the use of pesticides among potato producers during the last four decades. Farmers nowadays apply high doses of sometimes banned pesticides many times throughout the growing season.

The socio-economic transformations occurring in the last four decades have brought the farmers to lose part of the farming knowledge and decision making capacity that their parents instead had. In fact, farmers do not carry out the same traditional farming practices as older generations did, and the applications of pesticides take place without real knowledge regarding dosages, handling/storing methods and human health hazards. Farmers feel vulnerable in the face of increasing pest/disease attacks, and this feeling of perceived risk, that could lead to reduced well-being, is one of the component of their poverty.

Farmers are interested in IPM technologies to secure themselves from health hazards caused by pesticides use. Moreover, pesticides represent a high production cost, but this cost does not seem enough for the farmers to justify the adoption of IPM technologies, that would decrease harvests, and in turn revenues.

This study also demonstrated the extent to which farmers rely on informal nets of other farmers and relatives, and formal networks of technicians and potato experts, to acquire information about pest/disease management. Moreover, it highlighted the necessity, expressed by the farmers, to potentiate these networks in order for them to receive more useful information.

Some potential benefits of IPM technologies adoption within the project IssAndes in central Ecuador have been identified. IPM adoption could initiate processes of experiential learning among farmers, leading to the creation of new local knowledge, thus reducing the vulnerability felt by some farmers in the face of increasing pest/disease attacks. Furthermore, IPM trainings within IssAndes could enable farmers to strengthen the networks they already have, and create new ones, even outside the community boundaries. This increased access to some of the assets described in SL framework (human and social) would also bounce back to the financial asset found in the pentagon. The overall outcome could be a reduced level of poverty experienced by the households.

This thesis demonstrated the usefulness of the Sustainable Livelihoods Approach to deal with complex issues in rural contexts, where agriculture represents an important means for securing the necessities of life. The SL approach has been useful as it constitutes a new frame of analysis of the concept of poverty, to highlight power relations in the management of pests and diseases in potato production, and to link macro and micro levels of analysis. Yet this study found that, given the high level of complexity, the use of SL approaches can be sometimes daunting, and that SL framework does not take enough into account cultural and political aspects as part of the assets pentagon. The framework also does not differentiate between different social/ethnic groups, and does not explicitly address participation of all stakeholders, and should be directed more clearly to poverty elimination.

8 ACKNOWLEDGEMENTS

This Master Thesis was the outcome of a life experience that lasted more than two years. This section will therefore include a long chronological list of names that have accompanied me during this wonderful journey.

First of all, I would like to thank my mother, my father, my sister, my grandfather, my uncle Andrea and my aunt "la Zia Bella" for being my family, for having taught me to be curious and humble, for having always fed me with amazing food and loud conversations, and lastly for having let me take that flight to Sweden without any strong opposition. To Gabriella and Raffaele, for having witnessed my birth, to Dilly, for having played "Lupi" together, and to Giorgia, Benedetta and Ciro for being part of my adoptive family.

I would also like to thank my third family: Claudio, David, Francesco, Franco, Geppo, Luca, Marco, Nicco, Raffa for having shared with me thousands of moments since the age of six.

To my friends in Stockholm, David, Pierre, Kigge, Ilona, Ola, Leon, Andres, Loan and Mr. Miyagi, for having welcomed me as an old friend in your Lilla Sällskap, for having supported me while I was not able to find a job, and for having taken care of me the day after a big party. You made me grow up!

To my fellow Agroecologists, Fabian, Harilaos, Magnus, Robert and Sherif, for having started to dream with me about a different world. To the new Agroecologists, Carolina, Christopher and Johanna, for keeping the dreaming tradition alive.

To my friends at the Human Ecology program, for having participated with me in endless conversations about how bad the world looks like nowadays, and how hard we should work to re-construct it from scratch.

To Sofia, for loving the world around unconditionally. To Riccardo, for our "conversazioni spaccapalle". To Sanna, for the power of your smile.

To Julia, Sara, Veronica, Julia, Liene, Ali, Josephine, Suzanna, Sanna, Ana, Laura, Nora, Josephine, Lauri and the rest of "Ett Grönare Lund", for being the change they want to see in the world.

To Kristina Marquardt, Christina Kolstrup, Birgitta Rämert, Peter Anderson for making the fuzzy idea of a Master Thesis become a reality. To the rest of the teachers of Agroecology, for having brought me up to the fuzzy idea.

A special thanks goes to my supervisor at CIP, Peter Kromann, for having helped me during my field work in Ecuador. To all my colleagues at CIP, for opening a new perspective on your beautiful country. To Israel, Isabel, Leah, Gaby and Javi, for dancing salsa with me, for your laughs, and your smiles.

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10 APPENDIXES

Appendix 1

The two main biotic constraints in potato cultivation in Ecuador

Late blight (*Phytophtora infestans*) and Andean potato weevil (*Premnotrypes vorax*) are the two major biotic constraints among potato growers in Ecuador.

Late blight is caused by the pathogen *Phytophtora infestans,* an oomycete. In Ecuador, the pathogen has an asexual life cycle. In presence of humidity and right temperatures, zoospores are released from the sporangia, and once inside the plant, the mycelium keeps developing between the host cells, forming haustoria to penetrate the cells and new sporangia and the disease can develop explosively (Perez & Forbes, 2008).

The symptoms on the leaves are brown lesions, with irregular forms, sometimes surrounded by a greenish-yellow halo. On the stem, the symptoms are brown necrotic damages, between 5 and 10 centimeters, with a glassy texture, that usually start from the upper section on the plant. When the disease reaches the whole diameter, the plant easily collapses. The tubers that are affected by the pathogen have irregular areas, slightly sunken and brown-red colored, and subsequently rot in storage from secondary pathogen infection (ibid.).

In Ecuador, the climatic conditions in the highlands (mild temperatures between 12°C and 18°C, and frequent rainfalls followed by sunny periods)favor the development of the potato plant (Oyarzun *et al.*, 2002).

The Andean potato weevil is an insect belonging to the order of *Coleoptera.* The insect has a complete metamorphosis, i.e. in its life cycle it goes through four different stages: egg, larva, pupa and adult. The total duration of one cycle is around 134 days. Initially, an egg is posed inside the stem and, when it is matured, the larva comes out and migrate towards the rootlets of the plant and then towards the tubers, where it creates the most serious economic problems. Successively, the larva tries to find a sheltered place to carry out the stage of pupa, which lasts around 44 days. After that, the adult comes out and gathers with other adults in groups of 20/25 individuals attacking the potato plants at night (Herrera, 1997). Damages are caused on leaves (particularly the ones at the bottom of the plant, and at the final section of the branch), on stems and on tubers; the adults too can, , in absence of other sources of food, eat parts of the tubers. Even though the attacks on the tubers caused by the larva and the adult do not damage completely the product for home consumption or animal feeding, it reduces drastically its commercial value.

Sources of infestation can be the same seedbed, host weeds like *Plantago lanceolata* or *Rumex acetosella,* adjacent potato fields recently harvested or prepared, as well as potato seeds' stores.

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Appendix 2

Reducing the use of pesticides

One of the goals that CIP and the other institutions involved in IssAndes try to achieve is the reduction of agro-chemical inputs used by farmers for plant protection. Along the years, several technologies have been developed to control the two main biotic constraints (*Phytophtora infestans* and *Premnotrypes vorax*); these methods go under the umbrella of Integrated Pest Management (IPM): IPM is an ecosystem based strategy that aims at controlling and preventing pests and diseases in a long-term perspective, through a combination of techniques like biological control, cultural practices and use of resistant varieties; chemical inputs are seen as the last and inevitable solution and are sprayed only when monitoring shows that they are needed, and the application is done with the scope of removing only the target organisms (Flint & Gouveia, 2001).

INTEGRATED PEST MANAGEMENT OF ANDEAN POTATO WEEVIL (*Premnotrypes vorax*)

There are many different practices suggested by CIP to control damages caused by this insect:

To implement *Agricultural* practices that help to manage Andean potato weevil farmers need a certain degree of knowledge about the crop and the pest and its stages:

- Soil preparation, it helps exposing the larvae to the action of the sun, birds and other animals, as well as promoting that adults lose their pupal cell;
- Sowing date, to delay the date of sowing helps breaking the insect's life cycle;
- Complete harvest, necessary to leave the field empty from non-harvested plants and tubers;
- Crop rotation, it helps breaking the insect's life cycle, and thus reducing the population;
- Clean field period, the absence of any kind of plant on the field for roughly 30 days before the sowing date affects the surviving capacity of the larvae

Mechanic practices kill directly the insect or prevent it to access the field:

Refuge traps. They are used in order to attract the adults towards a specific place during the night by a small amount of potato foliage covered with a piece of cardboard or straw and to apply small doses of chemical or biological pesticides to the foliage in order to kill the insects. They work very well with loose soils. They are usually placed every 10 meters in a row, and the recommended number for 1 ha is 100. They can be used also for diagnostic purposes (to check how the population is spread in the fields); in this case the number of traps can be lower.

Bait plants. It consists in transplanting some potato plants or to sow some tubers more or less a month before the sowing date. These attract the adult weevils and it allows to kill them with small volumes of insecticide. A number of 100/ha should be put in the field, and each of them can kill around 800 adults in more or less 5 days time.

Border plants. Two or three rows of potatoes are sown along the borders of the field that is going to be cultivated with potatoes, around one month before the sowing date. After the emergence of these bordering plants, foliar insecticide has to be spread every 15 days until the main crop is completely emerged.

Traps to attract eggs. They function throughout the cultivation and it is an easy technology that also employs local materials. A bunch of *paramo* straws, or Rye grass stems, are placed along the rows or at the bottom of the plant, around 100/ha, and they attract adults that lay eggs there. They must be renovated every 15 days to avoid that the larvae that are born head to the potato plants

Plastic barriers. This method consists in placing plastic barriers 40/50 cm high (10 cm under the soil) all around the potato field. Adult of weevils are not able to fly, and therefore cannot migrate through the barriers; this method prevents adults to move from one field to another one. This technology has proven to be very efficient, but its implementation can sometimes be quite costly if the materials are not available locally.

Biological control, like the use of fungi *Beauveria* spp. and *Metarhizum* spp. aim at controlling the weevil population through the use of pathogens of the insect pest. The use of these two has proven effective, but no commercial formulations has so far been developed. Moreover, *Heterorhabditis* spp. and *Steinernema* spp. are being tested: these are nematodes that need rearing in laboratories inside the larvae of wax moths.

INTEGRATED PEST MANAGEMENT OF LATE BLIGHT (*Phytophthora infestans*)

Host resistance is one of the most effective ways to manage this disease (Oyarzun et al., 2002). The method is about taking advantage of the genetic resistance that some varieties might have, in order to hinder the development of the disease. There are two different types of genetic resistance in potatoes against late blight: the first one is called specific, vertical, qualitative, or complete resistance, whereas the second one is known as general, horizontal, quantitative or partial resistance. The first is governed by so called major R genes, that interact with the genes of avirulence of the pathogen; this mechanism of interaction is still the aim of much research, but we know that this type of resistance is specific depending on the pathogen race and it has not had much duration in the past . The second type has worked better in the field thanks to a pool of minor genes (additives). It is more stable and effective, theoretically, against all races of the pathogen (Perez and Forbes, 2008).

Until recently, there was not a standardized method to evaluate resistance to late blight in potato genotypes globally; the common practice was to divide them into very resistant, resistant, susceptible, and very susceptible. This classification can be useful in certain cases, but does not allow the researcher or farmer to quantitatively compare potato genotypes in different environments, nor to obtain effective information about amount of fungicide needed for the management of the disease in the specific variety. Another type of classification, based instead on the level of susceptibility, has been developed recently to allow for quantitative comparison (Andrade-Piedra et al., 2010; Yuen & Forbes, 2009).

Different varieties with their degrees of susceptibility are presented below (Table 10)

Table 10 : Main Ecuadorian varieties and their levels of susceptibility to late blight (Susceptibility scale value 0 = no susceptibility/immune. Susceptibility scale value 10 = highly susceptible. * native varieties) (Elaboration from Kromann (2012))

Variety	Susceptibility
Libertad	**1**
I-Victoria	**1**
I-Catalina	**3**
I-Fripapa	**4**
I-Estela	**4**
I-Raymipapa	**5**
Única	**5**
I-Natividad	**5**
Superchola	**6**
Yana Shungo	**6**
Chaucha Roja*	**8**
Diacol Capiro	**8**
I-Gabriela	**8**

Leona Negra*	**8**
Puña Negra*	**8**
I-Cecilia	**9**
Uvilla*	**11**
Coneja Negra*	**13**

Besides the resistance that each variety has, in general early varieties (varieties with a shorter season) are exposed to late blight for shorter periods than late varieties, and thus require less applications of fungicides (Torres et al., 2011) .

To implement *Agricultural* practices, like in the case of Andean weevil management, farmers need a certain degree of knowledge about the disease, its cycle and about the characteristics of the field where potatoes are going to be sown:

- Crop rotation, unlike the case of andean weevil, does not affect remarkably the development of the disease, as this is propagated through spores that can travel many kilometers;
- Appropriate tillage: even though it generally does not affect late blight, farmers in Carchi have reported a lower impact of this disease under the so called "*wachu rozado*"[20] ;
- Right fertilization: high doses of nitrogen increase the incidence of late blight, while phosphorus and potassium decrease it;
- Sowing date: it is very important to choose a right sowing date to avoid the period of highest incidence of late blight; in places where potatoes are grown all year long this is not always possible;
- Field selection: fields with a good drainage system and high ventilation are best suited to avoid this disease; moreover, since the severity of infection depends a lot on the temperature, fields located at higher altitudes with average temperatures lower than 8°C are less affected by late blight;
- Sanitation: to eliminate all sources of inoculum, like potato plants, weeds and intermediary hosts, helps decreasing the amount of disease. Yet farmers do not have so much influence on the sources of dispersion outside the farm;
- High hilling helps reducing the incidence of the disease thanks to the fact that drainage is more efficient and consequently leaves are drier, and also because the distance between leaves on the plant and leaves on the ground (possible source of infection) is higher;
- Selection and treatment of seeds is a good way to reduce the inoculum in seed potatoes (Torres et al. 2011; Sherwood, 2009; Perez & Forbes, 2008; Oyarzun et al., 2002).

Biological control consists of using one or more biological antagonists of *Phytophtora infestans*. Many microorganisms have an antagonistic effect (*Serratia* spp., *Streptomyces* spp., *Pseudomonas* spp., *Bacillus* spp., *Trichoderma* spp., *Fusarium* spp. *Aspergillus* spp., *Penicillium* spp., *Myrothecium* spp), but few have given a successful result in open field (Perez & Forbes, 2008).

Extracts or infusions based on garlic, onion or ferments of wheat, rice, barley etc., have given good results in experimental conditions, yet there is not clear evidence of its efficacy in open field . Spraying liquid compost or commercial bio-fungicide (based on *Bacillus subtilis*) is a solution that still has to be tested commercially (Perez & Forbes, 2008).

Andrade-Piedra, J., Kromann, P., Taipe, A. & Forbes, G. (2010). *Estimación del nivel de susceptibilidad a Phytophthora infestans en genotipos de papa*. [online] Available from: http://cipotato.org/region-

[20] *Wachu rozado* is a pre-colombian reduced tillage potato system

quito/informacion/inventario-de-tecnologias/EstimaciondelniveldesusceptibilidadaPhytophthorainfestans.pdf. [Accessed 02 03 2013].
Flint, M.L. & Gouveia, P. (2001). *IPM in practice. Principles and methods of integrated pest management*: University of California.
Kromann, P. (2012). (Personal communication) Levels of susceptibility of different potato varieties. In: Pellegrini, F. (Ed.).
Oyarzún, P., Gallegos, P., Asaquibay, C., Forbes, G., Ochoa, J., Paucar, B., Prado, M., Revelo, J., Sherwood, S. & Yumisaca, F. (2002). Manejo integrado de plagas y enfermidades. In: Pumisacho, M.*, et al.* (Eds.) *El cultivo de papa en Ecuador*. Quito: INIAP-CIP.
Perez, W. & Forbes, G. (2008). *Manual tecnico. El tizon tardio de la papa*. Lima: Centro Internacional de la Papa.
Sherwood, S.G. (2009). *Learning from Carchi: agricultural modernisation and the production of decline*. Wageningen, Netherlands: Wageningen Universiteit (Wageningen University). ISBN 978-90-8585-316-9.
Torres, L., Taipe, A. & Andrade-Piedra, J. (2011). *Manejo de lancha*. [online] Available from: http://cipotato.org/region-quito/informacion/inventario-de-tecnologias/manejo-de-tizon-tardio-o-lancha. [Accessed 01 03 2013].
Yuen, J.E. & Forbes, G.A. (2009). Estimating the Level of Susceptibility to Phytophthora infestans in Potato Genotypes. *Phytopathology* 99(6), 782-786.

Appendix 3

Rich picture

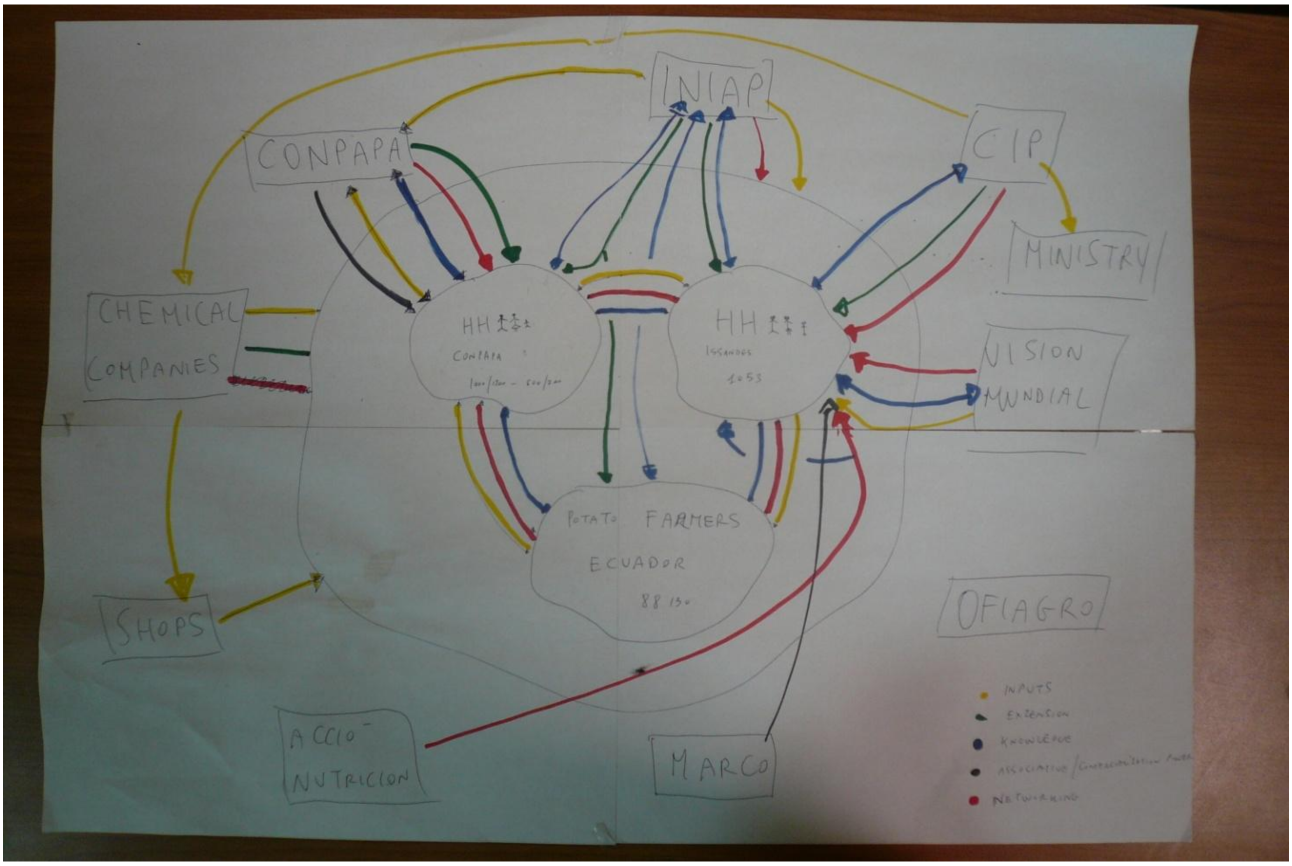


Figure 7 : Rich picture of the institutions part of the IssAndes project (Picture by Fernando Pellegrini, 2013)

Appendix 4

Kolb’s learning cycle

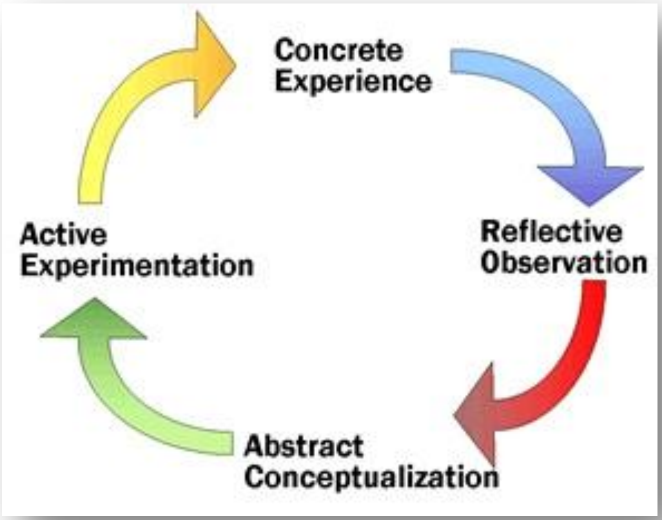


Figure 8 : Kolb's learning cycle (Picture adapted from Kirk (2010))

Kirk, K. (2010). *Experiential_learning. Kolb's cycle*. [online] Available from: http://www.flickr.com/photos/48047720@N05/4684200011/. [Accessed 03 04 2013].

Appendix 5

Interview guide

Name

Community

TIME TRANSECT

	Parents generation	Current generation
Quantity of woodland		
Weevil attack		
Late blight attack		
Pesticides use		
Rotation use		
Number of different potato varieties cultivated		
Wachu rozado use		
Mix of different crops in the same plot		

Questions that could accompany this table:

- ✓ What are the type of problems you experience the most, in comparison to your parents generation?
- ✓ What are the differences in farming practices, in comparison to you parents generation?
- ✓ What is the main obstacle that hinders you to go back to your parents way of farming?

What do you do to manage the Late blight?
Do you use pesticides? YES NO
Products in order of preference
1 ________ Quantity/number of applications
2 ________ Quantity/number of applications
3 ________ Quantity/number of application
How do you take the decision to do the first application?
Do you monitor the condition of the crop, before applying the pesticide?

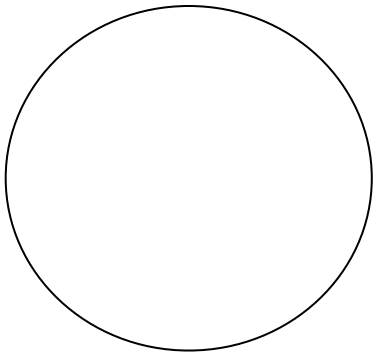
What do you do to manage the potato weevil?
Do you use pesticides? YES NO
Products in order of preference
1 ________ Quantity/number of applications
2 ________ Quantity/number of applications
3 ________ Quantity/number of application
How do you take the decision to do the first application?
Do you monitor the condition of the crop, before applying the pesticide?

How do you base your decisions about pest/disease management?

- ✓ What the retailer or what I read on the package label
- ✓ What I hear from other farmers
- ✓ My own knowledge
- ✓ INIAP/CONPAPA/Other institutions advices

Do you take part in farmers meetings? YES NO
Have you ever taken part in farmers trainings? YES NO
Have you ever taken part in farmers field schools? YES NO
What do you think about them? Did they help you? YES NO   From one to five? ____

Venn Diagramm Relations between institutions and farm about the type of information received in relation to IPM technologies.



Which are the 3 potato varieties that you like to cultivate the most?
Why? Based on which criteria?
Do you cultivate other varieties?

Do you know any method to control late blight/potato weevil, except pesticides use? SI NO
Do you use them? SI NO
Would you like to introduce a method that is allowing you to use less pesticides? Why?
Could you rank the reasons why you would introduce it?

- ✓ More income
- ✓ More health
- ✓ More environmental protection
- ✓ More capacity to decide, without the help of other institutions

Why are you not using such methods at the moment?

Appendix 6

Venn Diagram

Figure 9 : Venn Diagram developed at the community of Gualipite-Jatunpamba (Picture by Fernando Pellegrini 2013)

In this Venn Diagram, the community leader was asked to use the pot and the plastic pieces of paper to explain the institutions that lately have been most involved with the community. In the picture above, the cooking pot represents the community of Gualipite-Jatunpamba, the pink strip on the right corner is the pesticides company, the fluorescent piece of paper on the right is MAGAP, and the two other strips of paper represent two local organizations. The distance from the pot represents the frequency of interaction that the community has with the institution.