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LOCAL INNOVATION IN THE DEVELOPMENT OF  
SMALLHOLDER AGRICULTURE

A LITERATURE REVIEW AND CASE STUDY  
IN THE DEPARTMENT OF COCHABAMBA, BOLIVIA

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## TABLE OF CONTENTS

LIST OF TABLES	IV
LIST OF FIGURES	IV
LIST OF BOXES	IV
LIST OF ABBREVIATIONS	V
<b>1 INTRODUCTION</b>	<b>1</b>
<b>2 LITERATURE REVIEW</b>	<b>3</b>
2.1 Agricultural innovation	3
2.1.1 Definitions of “innovation”	3
2.1.2 Transfer of technology	4
2.1.3 System of innovation model	5
2.1.4 Participatory research and innovation approaches	7
2.2 Local innovation in smallholder agriculture	9
2.2.1 Defining local innovation	9
2.2.2 Triggers and driving forces for local innovation	11
2.2.3 Classification of innovations	12
2.2.4 Identification of local innovators and innovations	14
2.2.5 Documentation of local innovation	16
2.2.6 Diffusion and adoption of local innovations	19

<b>3</b>	<b>MATERIALS AND METHODS</b>	<b>23</b>
3.1	Study location	23
3.1.1	Natural resources	23
3.1.2	Human population and agricultural production	24
3.2	Data collection	26
3.3	Data analysis	29
3.4	Problems and constraints	29
<b>4</b>	<b>RESULTS</b>	<b>31</b>
4.1	Identification and documentation	31
4.1.1	Identification of the farmer innovators	31
4.1.2	Farmers' perceptions of participatory documentation	32
4.2	Farm and production conditions	34
4.2.1	Description of the farm	34
4.2.2	Socio-cultural aspects	36
4.2.3	Progress and constraints	36
4.3	Innovation in harvest conservation	38
4.3.1	Description of the silo	38
4.3.2	Construction process	40
4.3.3	Lessons learnt	43
4.4	Actors involved in the innovation process	43

<b>5</b>	<b>DISCUSSION</b>	<b>46</b>
5.1	Identification and documentation methods	46
5.1.1	Identification	46
5.1.2	Documentation	48
5.2	Defining and classifying the innovation	49
5.3	Innovation process and innovations	50
<b>6</b>	<b>CONCLUSION</b>	<b>53</b>
<b>7</b>	<b>SUMMARY</b>	<b>55</b>
<b>8</b>	<b>LIST OF REFERENCES</b>	<b>56</b>
<b>9</b>	<b>ANNEX</b>	<b>62</b>
9.1	Annex 1	62
9.2	Annex 2	63
9.3	Annex 3	64
9.4	Annex 4	64
9.5	Annex 5	65
9.6	Annex 6	66
9.7	Annex 7	66
9.8	Annex 8	67
9.9	Annex 9	68

## LIST OF TABLES

<b>Table 1:</b> Ecosystems, altitudes and cultivated crops .....	25
<b>Table 2:</b> Documentation tools.....	28
<b>Table 3:</b> Progress and constraints on the farm .....	37
<b>Table 4:</b> Traits and their effects of the two storage facilities .....	40
<b>Table 5:</b> Construction costs for the silo.....	41

## LIST OF FIGURES

<b>Figure 1:</b> Study location (Pojo District).....	23
<b>Figure 2:</b> Farm and resource map .....	35
<b>Figure 3:</b> Troja and silo compared.....	39
<b>Figure 4:</b> The improved silo .....	42
<b>Figure 5:</b> Local innovation - actors and their functions .....	44

## LIST OF BOXES

<b>Box 1:</b> Farmers' comments on documentation .....	33
<b>Box 2:</b> Lessons learnt in the innovation process.....	43

**LIST OF ABBREVIATIONS**

AIS	Agricultural Innovation System
AISM	Actor Innovation System Model
ARD	Research and Development
FAA	Foundation AGRECOL Andes
FFL	Farmer First and Last Approach
FSR	Farming Systems Research
ICT	Information and Communication Technologies
IK	Indigenous Knowledge
JOLISAA	Joint Learning in Innovation Systems in African Agriculture
NARS	National Agricultural Research System
PES	Parochial Extension Service Pojo
PID	Participatory Innovation Development
PRA	Participatory Rural Appraisal
PTD	Participatory Technology Development
PV	Participatory video
RRA	Rapid Rural Appraisal
ToT	Transfer of technology

## 1 INTRODUCTION

In many parts of the tropics, smallholder farmers are facing difficult conditions to earn their livelihoods from agricultural production. They have to cope with constantly changing production and marketing conditions. Furthermore, they try to improve their farming systems through innovation in production, efficient and continuous use of available resources, and influencing socio-institutional framework conditions.

Throughout the history of Agricultural Research and Development (ARD), various approaches and models of agricultural innovation for smallholder farming in developing countries have been formulated and applied to explain what the driving forces of innovation are and how to support agricultural innovation processes. The approaches show fundamentally different views on the origin and nature of innovation and the role of farmers, scientists and institutions in the innovation process. Many top-down approaches that have been applied have failed to take into account the facts that smallholder agricultural production is very specific to particular environmental, socio-cultural and economic conditions and that agricultural innovations have to fit into the local context. They do also not address the important potential of smallholder farmers as innovators in the process of developing locally adapted innovations.

To gain insight into local innovation and to enhance these processes, various approaches have been put into practice in the last two decades. They provide methods to identify local innovators and their innovations, to document the innovations with participatory approaches and to facilitate the promotion and diffusion of the innovations among other farmers and institutions.

The impact of local innovation on the sustainable development of smallholder agriculture and the potential of existing methods to enhance the local innovation process have to be examined to find answers on emerging issues on how to strengthen future smallholder agriculture in developing countries. To be able to promote smallholder innovation, it is important to find out how farmers perceive local innovation processes and how farmers and local institutions work together in joint site-specific innovation. These insights can, to

some extent, be achieved through participatory documentation of the innovations and innovation processes.

The following study has two main objectives. The first one is to review the literature on different approaches for understanding and supporting local innovation with the aim to situate local innovation processes and concepts in the context of agricultural innovation models.

The second is to explore the application of innovation identification and documentation methods on the basis of a case study carried out in Bolivia, specifically in Pojo District, in the Department of Cochabamba, so as to give an insight into farmers' perceptions of the participatory documentation approach. Moreover, the case study aims to draw an overall picture on how the innovation process and the impacts of innovations on the farm situation are perceived by the farmer innovators and to figure out interrelations and functions of involved actors in the innovation process.

## 2 LITERATURE REVIEW

The review is divided into two parts. In the first part, main models on agricultural innovation for development are briefly examined. In the second part, local innovation in smallholder agriculture is defined and approaches for the support of local innovation processes are reviewed from the literature.

### 2.1 Agricultural innovation

#### 2.1.1 Definitions of “innovation”

Innovation is a widely used term in several disciplines and contexts. It is a theoretical concept which is hard to grasp because of various interpretations and contexts of application. In the following, an overview on definitions will be given. Definitions on local innovation in particular will be given in detail in Section 2.2.1.

#### General definitions

First of all, it is necessary to define the meaning of *invention*, because it is often wrongly used as synonym for innovation. The verb *invent* means “to produce or design something that has not existed before” (JONATHAN, 1995), accordingly an *invention* is “a thing or an idea that has been invented” (JONATHAN, 1995). In contrast, *innovation* describes “the introduction of new things, ideas or ways of doing something”, or “a new idea/way of doing something that has been introduced or discovered” (JONATHAN, 1995). ROGERS (2003) states that innovation can be seen as “an idea, practice, or object that is perceived as new by an individual or other unit of adoption”. Thereby he underlines the fact that the newness of the idea depends on the perception of the individual and does not refer to newness in a global sense (which is fundamental to an invention). However, it is difficult to draw the line between invention, innovation and finally the diffusion, if each of them is not regarded as a single event but rather as part of an entire process (LUNDVALL, 1995).

There is a difference in using the singular and plural form of the term *innovation*. The singular refers to a process, the plural to a thing (CONROY, 2008). DOUTHWAITE et al. (2009) summarize *innovation* as “a process by which invention is put to use”.

In economic development science, *innovation* is defined as “the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business [farming] practices, workplace organization or external relations” (OECD, 1997). Some definitions are restricted to the technological level of innovation while others compass a wider range, including the organizational and institutional dimension of *innovation* (EDQUIST, 1997).

### **Innovation process and innovation system**

*Innovation process* refers to the change of a practice over time and *innovation system* to the relationships between the different actors participating in the *innovation process* (FAGBEMISSI et al., 2011). As the *innovation process* is forced and influenced by the interaction of different actors in certain circumstances, it can be defined as a system. Accordingly, an *innovation system* can be seen as a social system, “constituted by elements and relationships which interact in the production, diffusion, and use of new knowledge” (LUNDVALL, 1995). The interactive learning process between people is the main characteristic of an innovation system (LUNDVALL, 1995).

#### **2.1.2 Transfer of technology**

The classical model of Transfer of Technology (ToT) was widely promoted and played the dominant role in ARD in the 1960s and 1970s. This linear model sees research as the driving force of innovation and considers new technologies as the engine for rural development in developing countries. It is a hierarchical framework with research institutions at the top, transferring their knowledge to the beneficiaries without involving farmers’ knowledge and innovativeness in the development process. It simplifies the complex context of development without regarding social and particular local aspects (BIGGS, 2007). It is often also described as a “pipeline” model with an impact chain from basic research through applied and adaptive research to extension services and contact farmers and finally the widespread diffusion of the innovation among follower farmers (RÖLING, 2006). Scientists constitute the determining entity for setting the priorities on the research topics and conduct the experiments under controlled conditions. Often the research is driven by commercial interests, abetting technologies that are market oriented and resource intensive and that demand high levels of external inputs. This kind

of technology often cannot satisfy the needs of poor farmers in harsh environments with unstable production and market-access conditions (CHAMBERS & JIGGINS, 1987).

RÖLING (2006) puts the ToT model in the context of innovation processes influenced by liberal programs of structural adjustment to explain the contribution of ToT to the so-called “*treadmill*” where innovation leads to structural change in agriculture (concentration of production factors to early adaptors of innovations) and small resource-poor farmers are left behind. That is how the ToT model became a policy model where free markets assign development. Although there has been much evidence for the malfunctioning of the ToT model and the low adoption of technologies by farmers, the model is still applied (BIGGS, 2007). The official research framework for the conceptualization of ARD is the National Agricultural Research System (NARS), which still plays an important role in the developing world (ASSEFA et al., 2009).

### **2.1.3 System of innovation model**

The National System of Innovation approach came up in the late 1980s as a conceptual framework for innovation processes within defined national state boundaries (presuming that innovation processes depend on specific national assumptions and circumstances). It was the initial concept for other, more specific innovation models with emphasis on specific sectors, technologies and products. The general expression which includes the different derivatives of the model is System of Innovation (SI) (EDQUIST, 2001).

In his book on SI, EDQUIST (1997) defines an innovation system as a system that includes “all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations”. Analyzing all these determinants of a system from past to present leads to a better understanding on how to create an enabling environment for innovation initiatives.<sup>1</sup> This environment then becomes the basis for

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<sup>1</sup> An enabling environment is “a set of interrelated conditions – such as legal, organizational, fiscal, informational, political, and cultural – that impact on the capacity of development actors to engage in development processes in a sustained and effective manner” (THINDWA, 2001).

creating or strengthening relationships between the different actors. These linkages between actors stimulate interactions, leading to learning and innovation (HALL et al., 2006).

BIGGS (2007) formulated a more specified and applicable innovation concept for pro-poor ARD, called Actor Innovation System Model (AISM). He places special value on the identification and analysis of innovation processes in specific systems, which have already shown high positive and sustainable impact on local development.

Recently there are efforts to apply the SI model to ARD in developing countries to give a more holistic answer to the linear top-down model of ToT. Focusing rather on innovation as an interactive multi-actor process, the SI involves the “interaction of individuals and organizations possessing different types of knowledge within a particular social, political, economic, and institutional context” (HALL et al., 2006).

In 2006 the World Bank commissioned a number of case studies in Africa, Asia and Latin America to apply the SI concept to the agricultural sector. The results showed that the SI approach helps to understand the functioning as well as problems and constraints of present agricultural systems with respect to their ability to enable sustainable innovation processes. Applied to the agricultural sector the approach is, since then, known as Agricultural Innovation System (AIS). Suggestions for necessary *institutional* and *organizational* changes (see also Section 2.2.3) to enable innovation processes can be given with the AIS analysis. This refers to all involved actors from the public sector (e.g. policymakers, public extension services, education, labor unions etc.) as well as from the private sector (e.g. NGOs, involved entrepreneurs along the value chain, farmers’ organizations as well as consumers etc.) (HALL et al., 2006). The forthcoming World Bank sourcebook on AIS (WORLD BANK, forthcoming) gives a detailed insight into the principles of AIS analysis and action, focusing on the importance of several types of investments and interventions to strengthen innovation systems and on how these approaches and practices can be designed and applied to foster agricultural innovation processes in different contexts.

#### **2.1.4 Participatory research and innovation approaches**

Based on the emerging evidence of failures referring to the outcomes of the ToT model, over the years, participatory ideas came into ARD. They differed particularly in the degree of farmers' participation and the source of knowledge and innovation.

Two of the first models in this context are Farmer First and Last (FFL) and Farming Systems Research (FSR), arising from the Farmer First movement from the late 1980s onwards (CHAMBERS, 1983; CHAMBERS & GHILDYAL, 1985; CHAMBERS et al., 1989; SCOONES & THOMPSON, 2009).

The FSR approach takes into account specific information on farmers' resources, local circumstances and needs in order to define research topics and interventions for development. In the literature, there are controversial perceptions regarding the approach in terms of degree of farmers' participation and origin of knowledge and innovations. CONROY (2008) points out that FSR follows the conception of technological innovations originating only from formal research and institutions but, at the same time, farmers take part in the innovation process as consultants. In contrast, COLLINSON (2000) gives a more expanded definition on FSR where on-farm trials and farmers' innovations play an important role in the innovation process.

The first attempts to apply FSR were lengthy study processes going over several years before any on-farm trial was started. To accelerate the research process and the application of FSR in practice, Rapid Rural Appraisal (RRA) was developed in rural India and Sri Lanka (CONWAY et al., 1987). Farmers act as consultants for mapping and exploration activities on their farms and in their village areas, executed by the visiting researchers. Researchers are able to learn a lot about the farming system in a short time, especially about the particular circumstances on the farm, but farmers usually remain fairly inactive. A next step in the development of participatory approaches was Participatory Rural Appraisal (PRA), giving the farmers the active role of analyzing and planning their farm situation with the same tools used by researchers in RRA (SHAH & SHAH, 2011). RÖLING (2006) describes PRA as a "systemic process of reflective action

research, learning and decision making that leads to the emergence of innovation from their interactions”.

Another concept, which involves the participation of farmers and their knowledge for innovation even more, is Participatory Technology Development (PTD). It has to be distinguished from PRA, because it focuses particularly on the symbiosis of farmer and scientific knowledge and on partnerships to bring out innovations for the development of smallholder agriculture. There are numerous other approaches similar to PTD which basically share the same characteristics (ASSEFA et al., 2009). It can be questioned if it is useful to “re-label” known approaches or research techniques as new. In the end, the emphasis should be on their usefulness and sustainability in practice (BIGGS, 1990).

A recently established term related to the PTD approach is Participatory Innovation Development (PID). This refers to the process of identifying farmers who are already experimenting to improve their farming system and then engaging ARD bodies in joint farmer-led networking and experimentation activities. PID is an approach for development (farmer and NGO collaboration) rather than for formal research (WATERS-BAYER & VAN VELDHUIZEN, 2004). It puts emphasis on enhancing local farmer innovation processes that are based on farmers’ creativity and not only on problem-driven experimentation (ASSEFA et al., 2009).

The philosophy of participation is not only about using participatory tools and integrating farmers in developing their production and natural resource management (NRM) activities, but also about changing behavior and attitudes of researchers, extension workers and policymakers (WATERS-BAYER & BAYER, 2005). In 1985, RICHARDS already described a “people’s science” approach as a “decentralized, participatory ARD-system which seeks to support, rather than replace, local initiatives. The agricultural expert is replaced by the notion of an agent who is a catalyst and facilitator to meet localized research needs and to mobilize local skills and initiatives”.

## 2.2 Local innovation in smallholder agriculture

### 2.2.1 Defining local innovation

The definitions given in Section 2.1.1 can be seen as a theoretical foundation for the following view on how locally based innovation is defined in literature. There are several terms used for *local innovation*: farmer innovation (e.g. CHAMBERS et al., 1989; KOLFF et al., 2005), grassroots innovation (e.g. GUPTA, 2000) or endogenous innovation (e.g. ASSEFA et al., 2009; FENTA & ASSEFA, 2009). They all refer to farmer-driven innovation, some exclusively based on farmers' knowledge and initiative, others including the interaction with external knowledge sources and external support.

When we look for definitions of the term *local innovation* in the context of smallholder agriculture development, different emphasis can be found. One detailed definition is given by WETTASINHA et al. (2008). They quote that "*local innovation* refers to the process by which people in a given locality discover or develop new and better ways of doing things – using the locally available resources and on their own initiative, without pressure or direct support from formal research or development agents". Further on, they add that by using the term *local innovation*, "we refer to the dynamics of indigenous knowledge. By indigenous knowledge, we mean the knowledge that grows within a social group, based on learning from experience over generations but also including what was gained at some time from other sources but has been completely internalized within the local ways of thinking and doing". The outcomes of the *local innovation process* are defined as *local innovations*; concrete technological and organizational changes "that are new for that particular locality" (WETTASINHA et al., 2008).

Another aspect stressed in some definitions of *local innovation* is the restriction in terms of time. For instance, YOHANNES (2001) defines *local innovation* as "Something new, started within the farmers' lifetime – either a completely different way of doing something or a modification of an existing technique." Thereby he points out that the innovation has to be done in a single generation (or to be a modification of an inherited innovation) to be considered as innovation. In addition, CRITCHLEY (2000) states that a local innovation can be an unproven on going experiment or a new effective method.

Other definitions with different emphases have been worked out by institutions within an international network for the promotion of local innovation ([www.prolinnova.net](http://www.prolinnova.net)). They have been collected in WETTASINHA et al. (2008) and some are shown below:

“A different way of doing agriculture and NRM through creating new practices of modifying existing ones; bringing additional value over the common practices of the community, without affecting the broader environment and other innovation performance negatively.”

“A method or idea developed by an individual or a group without external support; a tested idea; a practical solution to a problem that an individual or group developed.”

“Local innovation is often based on IK, but takes this knowledge a step further by trying something new, something that had not been done before at that specific locality.”

“Local innovations may be: Traditional but modified; innovation brought from outside, but modified or value added in the local context; altogether new innovations; new innovations directly transferred from another location.”

To provide an insight into typical fields of local innovations, in the following some examples are listed (GUPTA, 2000):

- Conservation of local resources
- Generation of additional income
- Reduction or prevention of losses
- Control of pests and diseases in crops and livestock
- Conserving soil and water
- Improvement of farm implements
- Grain storage
- Conservation of land races
- Local breeds of livestock
- Conservation of aquatic and terrestrial biodiversity

There is a remarkable concentration on fields of innovation that depend on local production conditions and that are related to the use of local resources (e.g. livestock breeds, crop landraces, soil and water). The fields of innovation can be related to the triggers and driving forces for farmers to innovate (see next Section). Spontaneous and creativity-driven innovation, for instance, is often closely related to the experimentation with “visible” local resources. Innovations to increase the production outputs and the farm income (pest control, grain storage, reduction of losses etc.) or innovations to make more efficient use of scarce resources often have a problem-solving character.

### **2.2.2 Triggers and driving forces for local innovation**

In history, before ARD and structured scientific innovation approaches emerged, local innovation by farmers was the means for any kind of change and improvement in smallholder agriculture (CRITCHLEY, 2000). Farmers always have been using their knowledge to innovate, doing informal experimentation (farmer innovators) (WATERS-BAYER & VAN VELDHUIZEN, 2004). Even after exogenous innovation forces had been established trying to introduce technologies from outside (see Section 2.1.2), farmers kept on experimenting and adapting their systems. Several studies have shown that there is still a broad potential of indigenous knowledge based innovation used by farmers to improve their systems (e.g. CRITCHLEY & NYAGAH, 1999; REIJ & WATERS-BAYER, 2001b; SANGINGA et al., 2009). To understand and enhance these local innovation processes, the questions have to be addressed: why farmers do innovate and what are the leading impulses to induce innovation processes?

In general, the main triggers can be divided into problem-induced and opportunity-induced (KNICKEL et al., 2009). In poor smallholder agriculture, the first is often a main stimulant, occurring from being confronted with environmental stress like droughts, floods, poor soil fertility, pests and diseases (FAGBEMISSI et al., 2011). Economic needs are very often important drivers and sometimes also a crisis (economical, environmental etc.) can be the starting point for innovation (KNICKEL et al., 2009).

Another classification identified by MILLAR (1994) defines four types of experimentation triggers: firstly the experimentation *based on curiosity*, secondly *problem-solving efforts*, thirdly *adaptive trials* and fourthly *peer pressure driven* experimentation.

Following the *curiosity* aspect which leads to innovative behavior, it is important to recognize that there is a natural creativity of farmers to experiment and to try new ideas. Problems are not the only stimulant for farmers to innovate. Some of them have increased awareness of scarce resources and the importance of environmental protection. They can be described as “people who look for positive interactions and synergies” (CRITCHLEY & NYAGAH, 1999).

Furthermore, it can be differentiated whether the innovation process is triggered by opportunistic and spontaneous behavior of farmers (individuals) or if it is a real orchestrated and organized process (HALL et al., 2006). Both the individual opportunistic and the orchestrated initiatives are important drivers for innovation, but there is no evidence of which one is more successful (KNICKEL et al., 2009).

To conclude, SEPPÄNEN (2004) argues that, on the local level, there is always a “meaning-creation” by farmers, which is to say that they deconstruct and recompose exogenous innovations, an “endogenous translation of exogenous innovation”. Accordingly, it can be deduced that external innovations may also be a trigger or driver for local innovation.

### **2.2.3 Classification of innovations**

The classification of innovations aims to extend the narrow view on the technological layer of innovation and to understand the diversity and complexity of innovation (FAGBEMISSI et al., 2011). LEEUWIS & VAN DEN BAN (2004) point out the “composite nature” of innovations that often have several dimensions (technical and social practices on the farm). The classification is necessary to approach the different dimensions of an innovation for the understanding of adoption and adaptation by farmers (see also Section 2.2.6). Moreover, different types of innovation are commonly intertwined (organizational, institutional, technological etc.). To recognize and analyze these interdependencies of different innovations, they need to be classified to measure the success of an innovation process (KNICKEL et al., 2009). In the following, different classifications will be presented.

According to the drivers of innovation described in the last section, the outcomes of local innovation can be of different types. A classification in a general theoretical context of innovation theory is given by EDQUIST (2001). He classifies process and product innovation. Process innovation refers to technological innovation (e.g. a new farming practice or improvement of post-harvest storage) or organizational innovation (e.g. farm cooperation between neighbors or organization of labor) while product innovation is sub-classified into goods (e.g. integration of new market crops or animal products) and services (e.g. changes in product marketing).

Another classification which applies specifically to agricultural innovation has been drawn in the final report of the program “Innovation processes in agriculture and rural development” (KNICKEL et al., 2009) and the “JOLISAA (Joint Learning in Innovation Systems in African Agriculture) project” (FAGBEMISSI et al., 2011). The first category is *economic innovations*; which refers to strategies to increase income and profit (marketing strategies, e.g. forming farmer cooperatives). The second category is *social innovations*; focusing on networks and relations between the actors involved in the agricultural environment (producer, consumer, farm-input supplier, extension service etc.). The common-learning aspect of social innovations plays a crucial role for the implementation and adoption of economic and technological innovations. The third category is *organizational innovations*; here, the emphasis is on farm management changes to improve the distribution and efficiency of labor and to build partnerships between e.g. farmer and butcher/miller or between local farmers to cooperate in farming activities. The fourth category is *technological innovations*; which refers to all kinds of innovation related to methods of production, machinery and infrastructure as well as technical solutions for logistics and marketing. The JOLISAA project adds a fifth category which consists of *institutional innovations* that contribute to ensure that all other innovation processes are successful (an institutional framework to create an enabling environment for innovation).

A further classification, given by CONROY (2008) differentiates between minor, medium and major innovations, according to the degree of change they evoke in comparison with existing practices. Minor is associated with the term evolutionary and major with the

term revolutionary, pointing out a slow and modest or a fast and drastic change, respectively. *Minor innovations* can be realized without or with very little increase of each factor of production (e.g. new crop varieties, change of seed timing). *Medium innovations* require a high increase of inputs (e.g. introduction of cross-bred milk cattle which may require more fodder and veterinary inputs). *Major innovations* refer not only to the replacement of a technology but also involve changes in the farm organization or management (it may even include a change of the production system).

The purpose and coherence of the latter classification can be critically assessed, since the differentiation between *minor*, *medium* and *major* refers firstly to the degree of change it evokes and then to the required degree of increase in production factors. It cannot be assumed that a simple adjustment, for instance, the introduction of a new crop variety or change in seed timing, may not cause a significant change in the production system. The term *evolutionary* in relation to *minor* innovations may be interpreted as a natural and somehow *passive* process of innovation. Small adjustments through *active* experimentation with locally available resources are typical for farmers' innovations and, in local terms, they can even be regarded as *revolutionary*.

#### **2.2.4 Identification of local innovators and innovations**

As it was shown in the previous sections, local innovations are diverse. Farmers with different profiles can be expected to be innovators. Sometimes, even farmers of the same village do not know about the innovations their neighbors are experimenting on (GUPTA, 2000). The identification of local innovations can be regarded as the crucial beginning in creating equal relations between institutional development actors and farmers to recognize the value of farmers' knowledge and their capacity to innovate for sustainable development (WATERS-BAYER & VAN VELDHUIZEN, 2004). According to experiences within the "Promoting Farmer Innovation" research project in different East African countries, the identification of farmer innovators and their innovations was easy for scientists and extension agents (CRITCHLEY & NYAGAH, 1999). It is necessary to review different approaches to identifying farmer innovators, as farmers are not always aware that they are innovating. Experimentation is part of daily on-farm activities and often cannot be seen as a particular action separate from routine farm work (RICHARDS, 1989; DEN

BIGGELAAR & HART, 1996). It may be even more difficult to identify an innovation if it is a still on-going experiment of one single farmer.

### **Common traits of innovators**

To identify innovative farmers, first of all it is of interest to know how innovators can be described and what type of people often become innovators. In a research study on local innovators in Tanzania, KIBWANA (2001) found out that innovators are often middle-aged men with families, official position holders in their locality and/or responders to problems faced during their daily farm activities. Most of them indicated to have been inspired by their own ideas and curiosity. In his study on community assessment of local innovators in northern Ethiopia, YOHANNES (2000) analyzes that they are often people who resettled in the locality, bringing new ideas to experiment with from a different environment. Other studies in East Africa point out the traits of innovators as being dependent on their land, picking up advice from outside to combine this with their own ideas, focusing on intensified and integrated use of resources and showing pride in their innovations (CRITCHLEY & NYAGAH, 1999).

When identifying innovators, traits like age or family status might not be very relevant, as the above-mentioned studies show variable results on these parameters. However, it has been found that the innovators identified by outsiders are mainly men, even though there are a number of examples where women take the leading role as innovators (e.g. WATERS-BAYER, 1988; WETTASINHA & WATERS-BAYER, 2010).

The gender aspect in identifying local innovators was addressed by CRITCHLEY & NYAGAH (1999) working in East Africa. They found that the identifiers of male innovators are men, too, and that male innovators often present an innovation made by their wives as their own. Due to these and other reasons, the identification of women innovators is more difficult, being constrained also by other cultural aspects (in this case, in African countries). The real participation and role of women in local innovation processes can only be approximated.

### **Methods to identify innovators and innovations**

There are a couple of procedures to identify innovators and innovations. A methodology published by HAILE et al. (2001) proposes four approaches. The first one is observation in the field, paying attention to “everything what appears unusual”. Also conversations and discussions with the farmers met can give indication. The second one is to contact key informants who may be local leaders or older inhabitants and ask them for names of farmers in the community, who are known as people who try out things which have not been there before or who do techniques differently. The third one is to “trace the history of an innovation”. That means to ask for older innovations that had been established in former times and to identify the person or a group involved in developing the practice (it can happen that the original innovator already died and the second or third generation, which is still adopting and using the innovation, has to be identified). The last one is to “identify farmers who did not accept extension packages” because they often use the new knowledge to integrate it into their own ideas.

Within the Honey Bee Network ([www.sristi.org](http://www.sristi.org)) in India, the identification of innovators is carried out by students during their vacations in rural areas. Another approach is to organize competitions among ARD and educational institutions. Also observations take place during agricultural fairs to find out the “oddballs”. Furthermore, there are regularly organized walks in the villages to identify innovators (GUPTA, 2000).

#### **2.2.5 Documentation of local innovation**

Once the local innovators and innovations have been identified, the further step to enhance local innovation is documentation. It is commonly argued that the main purpose for documenting local innovations is to share information and experiences among a wide range of stakeholders (farmers, extension agents, researchers and policymakers). By sharing knowledge and experiences about local innovation, a process of interaction can be enhanced to spread, evaluate, adopt or even use the documented innovation process and its outcomes for further experimentation by farmers and institutions (RÜTER-NOORDZIJ & PIEPENSTOCK, 2006; CHAVEZ-TAFUR et al., 2007; WETTASINHA et al., 2008, VAN VELDHUIZEN et al., 2012).

There are a number of approaches to documenting local innovation. In practice, documentation is often done by outsiders in an extractive manner; farmers act as informants and the information is kept outside the community reach (RÜTER-NOORDZIJ & PIEPENSTOCK, 2006). This documented information cannot serve its purpose or may even become lost if access is not guaranteed to all stakeholders (primarily farmers), e.g. caused by language or illiteracy barriers (CHAVEZ-TAFUR et al., 2007). Extractive approaches often focus on technological innovations and practices and pay little attention to the particular innovation process and the local conditions. In the World Bank publication series on indigenous knowledge, WATERS-BAYER & VAN VELDHUIZEN (2004) point out that most local innovations are very specific to the conditions where they are developed and that documentation should rather emphasize the innovation process, focusing on involved actors and their specific experience. Respectively, the following questions should be addressed: what are the motivations, how was the innovation put into practice and what is the innovation context?

FRIIS-HANSEN & EGELYNG (2007) point out that approaches for enhancing local innovation processes, as in the present context the documentation, should not focus on the innovation by itself but also on the “promotion of a culture of innovation and learning in rural communities”.

Recently, there are new approaches towards participatory *farmer-led documentation* (RÜTER-NOORDZIJ & PIEPENSTOCK, 2006). They imply that farmers take the leading role in documenting their innovations. Different documentation tools and arrangements are used, depending on the readership/audience of the documented material, the cultural context and on skills, funds and equipment available (WETTASINHA et al., 2008). There is a wide range of documentation tools described in literature and most of the approaches propose using a mix of different tools. Many of the tools are based on visualization and vocal recording of farmers’ experience. One methodology of participatory documentation was elaborated and published in Bolivia. This puts emphasis on training farmers in the use of Information and Communication Technologies (ICTs), mainly digital camera and computer) to take pictures of what they think is interesting and important and then putting them into a PowerPoint-designed presentation with a description of their

innovations to share their experience with other farmers (PIEPENSTOCK et al., 2006). This methodology was applied in several communities in Bolivia.<sup>2</sup>

The use of Participatory Video (PV) is another tool; farmers make their own video spots of their innovations (LUNCH & LUNCH, 2006). A study in Ghana has shown positive outcomes of a PV documentation made by women innovators when the video was shared with other farmers. It is stated that PV provides an opportunity to enable “joint learning by outsiders and community members with a view to perfecting ideas” (BRUCE et al., 2006).

The use of ICTs enables visualized documentation in regions with high illiteracy, but it is also recognized that these technologies are delicate and expensive (RÜTER-NOORDZIJ & PIEPENSTOCK, 2006). It also has to be admitted that ICTs require a routinized and frequent use to maintain the gained knowledge on its use (software etc.).

Another tool is the voice-recorded interview. These interviews are used in cooperation with local radio stations to make broadcast programs on local innovation (e.g. NASR et al., 2000; ABAY & GEBREGIORGIS, 2011).

Print media are also promoted to share documented local innovation (WETTASINHA et al., 2008). Publication of catalogues provides an inventory of collected innovations (also in form of online platforms: e.g. Honey Bee Network); posters can be used to expose innovations at exchange fairs, farmer-organization meetings etc. and magazines can be published to reach “a wider and specific readership” (WETTASINHA et al., 2008).

An approach developed in the framework of a project in Central America focuses on so-called farmers’ testimonies (HOCDE et al., 2000). Using recorded interviews with assistance by farmers writing about their innovations, the innovation is put into the entire life-context of the innovator to create an individually illustrated document with the following given structure: *My life, my experiments, benefits of experimentation and dissemination of results*. Within the same project, a book was designed (“*farmer’s diary*”) and spread

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<sup>2</sup> For publications of leaflets, presentations and videos see [www.agrecolandes.org](http://www.agrecolandes.org)

among the communities to motivate farmers keeping daily records of their activities and experiments.

DOUTHWAITE & ASHBY (2005) present a methodology to create an *innovation history*. It consists of a joint learning process, which implies that all actors involved in an innovation, document and reflect on the process to encourage new innovation potential.

Most of the approaches described above arise from extension initiatives with support from researchers and their institutions. There was no literature found on cases where farmers initiated processes of structured documentation of their innovations based only on their own initiative. This might be due to the fact that farmers do not publish about their own initiatives in documenting their innovations.

### **2.2.6 Diffusion and adoption of local innovations**

In the previous sections, innovation in the context of ARD was examined and methods were reviewed on how to identify and document local innovations with the aim of enhancing their diffusion and to create a culture of innovating in rural communities. In this section, the diffusion and adoption of local innovation will be reviewed.

The *diffusion of innovation* is defined as “the process in which an innovation is communicated through certain channels over time among the members of a social system” (ROGERS, 2003). Regarding the diffusion of *innovation*, the communicated message is characteristically about new ideas. While diffusion relates to the “spreading of innovations in a community”, *adoption* refers to “the uptake of innovations by individuals” (LEEUIWIS & VAN DEN BAN, 2004). Diffusion usually refers to the spontaneous or planned communication of new ideas, although some definitions use the term dissemination for the planned spreading of innovations (ROGERS, 2003).

Mainstream approaches for the diffusion of agricultural innovations (see Section 2.1.2) promote the one-way (top-down) communication of new ideas from research and extension to the adopters (farmers) (LEEUIWIS & VAN DEN BAN, 2004). However, the research on diffusion of innovations has shown that adoption is a selective learning process (cf. also DOUTHWAITE, 2002) which requires two-way communication.

That becomes clear when we look at the individual decision-making process of adopting or rejecting an innovation. ROGERS (2003) divides the process into five stages:

- Knowledge: about the existence of an innovation
- Persuasion: shaping attitudes towards the innovation
- Decision making: adoption or rejection of the innovation
- Implementation: adapting the innovation and putting it into use
- Confirmation: seeking reinforcement from others for decisions made, leading to continuation or discontinuation.

Adoption is a complex process that individuals or groups undergo. Rejection of an innovation may occur even after implementation. The described stages confirm the assumption that adoption is a selective learning process implying that information is exchanged and processed to decrease *uncertainties* of the adopter about the innovation (ROGERS, 2003). *Uncertainty* can be regarded as a leading constraint in the adoption of innovations and has to be considered when designing the diffusion of (local) innovations for smallholder agriculture.

ROGERS (2003) set up categories of people to calculate the adoption rate and to characterize the behavior of individuals, depending on the point in time when they adopt an innovation. The first group represents the *innovators* themselves, followed by the *early adopters*, the *early majority*, the *late majority* and finally the *laggards*. This classification is often used for judgmentally classifying individuals in the process of the diffusion of innovations developed by formal research, without taking into account *why* farmers do not adopt the innovation. They may have good reasons, unapparent to outsiders. Another reason could be that they have other sources of innovation, for instance from their own experimentation with alternatives (LEEUWIS & VAN DEN BAN, 2004).

Reviewing recommended media for the diffusion of innovation, it appears that, for the diffusion of local innovations in remote areas with limited access to agricultural mass media, interpersonal communication is most effective (ROGERS, 2003). This is not only because of the absence of mass media (one-way communication) but also due to the fact described above that adoption is a selective social learning process (based on two-way communication). The interpersonal diffusion of an innovation can be realized by farmers

or agents (extension service, local authorities and leaders etc.). They are called *opinion leaders* and may function as *information brokers* who bring information about new ideas from outside into the diffusion system (e.g. community or a single farm). Confident and stable relationships between the opinion leader and the adopters are regarded as important for successful diffusion. A related constraint to adoption is *heterophily*, which is “the degree to which individuals who interact are different in certain attributes (beliefs, education, socioeconomic status etc.)” (ROGERS, 2003). Accordingly, adoption is more likely to be successful if the communication partners have similar attributes (*homophily*).

For the case of local innovation in smallholder agriculture, it means that farmer-to-farmer learning activities and on-farm demonstrations can be expected to be the most successful diffusion method. It is important to factor this awareness in when documentation and diffusion approaches described in the previous section are implemented and farmer innovators themselves are asked to promote their innovation among others. ROGERS (2003) emphasizes that adopters subjectively evaluate an innovation by communication with other farmers and observation of other experiences rather than by evaluating scientific findings.

Applied research reveals many reasons for the functioning and nonfunctioning of diffusion of (local) innovation. Some are related to the communication framework (as described above) and others to the innovation itself. In general, it has to be carefully analyzed if an innovation is really valid for diffusion, since too many new ideas and variations make people feel uncertain and may prevent them from adopting and innovating on their own (DOUTHWAITE, 2002). Innovations are unlikely to be adopted if they depend on expensive external inputs or require high demand of labor or skills (CRITCHLEY & NYAGAH, 1999). DOUTHWAITE (2002) found that the more a technological agricultural innovation is adapted to the local conditions, the more likely it is to be adopted by farmers. Social constraints are summarized by CRITCHLEY (2000). He wonders whether the planned support of a certain local innovation (identification, documentation, diffusion etc.) may hamper the natural process of local innovation by farmers. This could be due to the uneven diffusion of innovation that may cause comparative advantages/disadvantages in a region or community. Furthermore, social conditions

between farmer innovators, when they are promoters and peer adopters, may hinder the diffusion if disharmony occurs. Innovators may cause jealousy or antipathy among other community members instead of representing a positive example, for instance, when they are out of the norm (in their social behaviour) or when they receive support from extension services.

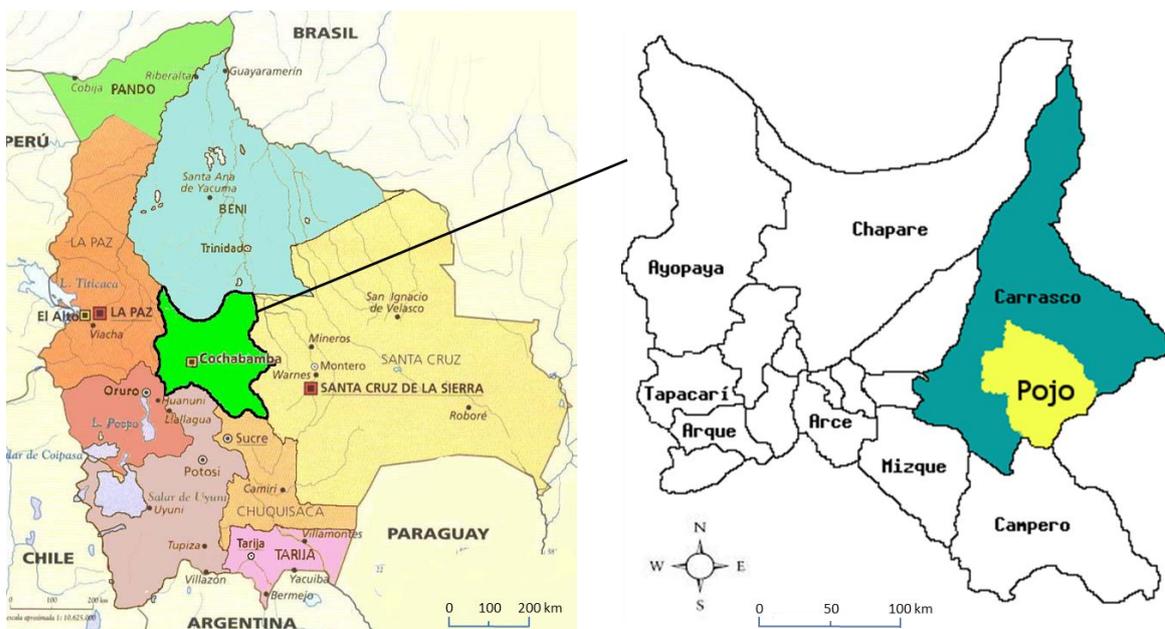
Summarizing the described aspects of diffusion and adoption, it appears that there are many aspects to be considered in the process of conceptualizing the planned diffusion of local innovation in the development of smallholder agriculture.

### 3 MATERIALS AND METHODS

#### 3.1 Study location

The present case study was carried out in the community of Duraznillo situated in the central Andean highland district of Pojo in the Department of Cochabamba, Carrasco Province, Bolivia (Figure 1). Pojo is situated 200 km south-west of the department capital Cochabamba and extends from latitudes 16°52" to 17°56" South and longitudes 64°04" to 64°12" West. The community of Duraznillo lies at an altitude of 2500 m a.s.l., 40 km north of the district capital Pojo.

**Figure 1:** Study location (Pojo District)



Source: Adapted from: [www.justmaps.org](http://www.justmaps.org) & [www.mapadebolivia.com.ar](http://www.mapadebolivia.com.ar), 15.12.2011

##### 3.1.1 Natural resources

The mountainous central Andean massif in Pojo District includes a wide range of geological conditions and climatic zones at altitudes from 1400 to 3700 m a.s.l.<sup>3</sup> Highly variable topographic landscapes are characteristic, containing high mountain chains, hills,

<sup>3</sup>Unless otherwise specified, information in Section 3.1.1 originates from the municipal development plan of Pojo District (PDM Pojo, 2008).

high and medium valleys as well as alluvial river valleys. Various climatic zones and ecosystems can be found at different altitudes (see also Table 1 in Section 3.1.2). The Duraznillo community is located in a semi-arid zone. There is a long dry season from March to October and a short rainy season from November to February. The average annual precipitation is 591.6 mm in the higher regions and 458.18 mm in the lower valleys. The mean temperature is between 11.7°C and 17.6°C depending on the altitude. Due to the high variability of altitude and exposition, there are microclimates with specific climatic characteristics, determining the possibilities for agricultural activities (VASQUEZ, 1987).

Pojo District covers 4700 km<sup>2</sup>, of which 2670 ha belong to the Duraznillo community. The land-use distribution in the community area consists of 643 ha arable land and 2023 ha rangelands (1760 ha are declared as natural grazing areas). Rain-fed cultivation dominates with 640 ha; only 3 ha are under irrigation and the native forest is restricted to few areas (4 ha). More than half of the soils are classified as highly eroded (57 %).

There is one river within the community's territory carrying water only three months of the year. The community water supply is secured by six natural springs. Sources of energy for cooking and heating are timber (72 %) and liquid gas (32 %). There is no electricity in the community.

The communities in the district are more or less connected with dirt roads and there is one partly tarred main road between Cochabamba and Santa Cruz. Some of the communities can only be reached on small walking tracks.

### **3.1.2 Human population and agricultural production**

In 2001, the human population in Pojo was 111,515 (2.5/ km<sup>2</sup>) (INE, 2005). The dominant ethnic group is the indigenous-descended Quechua-speaking people (80 % of the population). In the Duraznillo community, there are 271 inhabitants living in 80 families (3.4 people / family). 140 persons speak both Quechua and Spanish; 131 speak only Quechua. With regards to the religious denomination, 80 % are Catholics and 17 % Protestants.

In Pojo, 80 % of the inhabitants are involved in agricultural activities. Agriculture and animal husbandry are mainly family-based and carried out in small-scale, mixed farming systems with a low degree of mechanization. The average farm size ranges between 0.5 and 2 ha with a varying percentage of crop production and livestock keeping. Due to the variability of altitudes and climate, a wide range of crops and livestock can be found in different ecosystems (Table 1). In crop production, potatoes, cereals and field beans and in the lower regions vegetables as well as several fruits are important for marketing as well as for self-consumption. Because of rain fed crop production is limited to the rainy season, seasonal migration to the cities or to the tropical lowlands for wage labor is widely practiced (Lovón, 2004).

**Table 1:** Ecosystems, altitudes and cultivated crops

Ecosystem	Altitude [m a.s.l.]	Cultivated crops	Livestock kept
Cabecera de valle	3800 - 3000	Potato, oat, field bean, ulluco ( <i>Ullucus tuberosus</i> ), oca ( <i>Oxalis tuberosa</i> )	Goat, sheep, cattle, horse
Valle	3000 - 2800	Potato, pea, oat, field bean, wheat, barley	Goat, sheep, cattle, horse
Valle cálido	2800 - 1900	Potato, oat, field bean, onion, vegetables, peach, fig, apple, opuntia ( <i>Opuntia ficus-indica</i> ).	Cattle, sheep, goat, donkey
Yungas	1900 - 1400	Potato, tomato, pea, sugarcane, groundnut, sweet potato, vegetables, mandarin, peach, banana, avocado	Cattle, sheep, goat, pig, aviculture

Source: Elaboration by the author based on data from the Pojo municipal development plan (PDMa 2010).

Livestock keeping plays an important role, offering not only animal products for the households but also assuring the household income during the long dry season (HELBINGEN, 1997). Animal products are milk, (dried) meat, cheese, wool and skins. Livestock is rarely sold and animals are commonly used for draft power in the field and for transportation (oxen, horses and donkeys). In the higher regions (> 2800 m a.s.l.), where fodder availability is low, mostly sheep and goats are kept to exploit the rangelands. They are herded during the day and kept in corrals for the night.

Referring to the marketing of agricultural products, there is a small intermediate market in Yuthupampa (approximately 15 km from the community of Duraznillo), but products are also sold on the big markets in the city of Cochabamba (MORÉE, 2002).

### 3.2 Data collection

The present case study was conducted during an internship in the nongovernmental Foundation AGRECOL Andes (FAA) in Cochabamba, Bolivia. The activities carried out during the internship included participatory documentation and promotion of local innovations in smallholder agricultural systems in the Andean region. Data collection was embedded in activities of identification of innovators and innovations and documentation together with farmers.<sup>4</sup>

For the identification and documentation, various methods were applied to capture information and data from multiple sources and informants. Out of various identified farmers, one case was selected for this study and the innovation was then documented on the identified farm. The process of identifying farmer innovators was observed and documented with notes and pictures. A description of the identification process will be given in Section 4.1.1. The participatory documentation itself was the main source of information to find the farmers' perceptions on the innovation process and innovations.

Additional information on involved actors in the innovation process and local circumstances of the study location was obtained during joint documentation planning activities with the local NGO Parochial Extension Service of Pojo District (PES).

Impressions of smallholder agriculture and current innovation processes in the region were gathered by visiting numerous communities and during other documentation activities in Pojo District and in the neighboring district Aiquile.

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<sup>4</sup> In the frame of the project "Incidencia política para un desarrollo territorial basado en la agricultura sostenible" (Influence on local policy-making processes for a territorial development based on sustainable agriculture), executed by the FAA. For detailed project description, see also the FAA webpage: <http://www.agrecolandes.org/fichas2010/F-MSR-2010.htm>

### Participatory documentation

The documentation took place on 16<sup>th</sup> of December 2010 on the farm of the selected family (family name: Pinto) in the community of Duraznillo<sup>5</sup>. The documentation focused on the innovation of an improved post-harvest storage facility. Beside the Pintos family, another identified farmer from the nearby community Yuthupampa with experiences in constructing an improved storage silo was invited with his wife (family name: Malma). Both families received support from the PES, and they have similar production systems and environmental conditions. The focus was on the experience of the Pintos family, but some information on the experience given by the Malmas family was also documented.

As the author of this study does not speak the Quechua language, all documentation activities were translated by a PES agent from Quechua into Spanish.

Methods for participatory documentation were selected from different sources. Most tools were taken from a publication of the FAA on participatory documentation (PIEPENSTOCK et al., 2006). For inspiration on the practical application of these tools and for the theoretical background on how to facilitate participatory on-farm research, other sources were consulted (GONSALVES et al., 2005a, GONSALVES et al., 2005b, ORIGONE, 2006, CHAVEZ-TAFUR et al., 2007).

In Table 2, selected participatory tools for the documentation are listed. The *resource map* of the farm area was jointly drawn by the farm family (with the participation of the 14-year-old daughter), to give a visual overview on the farm size, available resources, cultivated crops and livestock numbers. The *progress and constraints diagram* is the result of a discussion among all participants. The farmers' statements were written down in the diagram to work out the main problems in terms of production, economic situation as well as the socio-cultural aspects on farm and community level. The *timeline of the innovation* was drawn by the farmers to show the innovation process on a time axis from the early beginning until now and to give a forecast on the future objectives. Apart from marking the technical steps of the implementation, crucial details with regards to ideas,

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<sup>5</sup> See Annex 9.8 for documentation schedule

problems and involved actors were pointed out. A *working procedure diagram* was filled in by the facilitators according to the information given by the farmers on technical details and working steps, as well as for a calculation on labor and costs of the innovation. To give a visual comparison of the old and the new storage facility, the farmers made a *before-after drawing*. The farmers' statements were recorded with a voice recorder while the family members explained their drawings, and the PES agent conducted a semi-structured interview with Mr. Pinto in the Quechua language.

**Table 2:** Documentation tools

Tool	Purpose
Resource map	Details on the farm
Progress and constraints diagram	Show difficulties and achievements on production, economic and socio-cultural level
Timeline of innovation	Visualize the innovation process
Working procedure diagram	Indicate the implementation step by step, including costs for material and labor
Before-after comparison drawing	Work out improvements achieved with the innovation in comparison with traditional practices
Joint walk on the farm	Get to know the farm and innovations by observation and with explanations given by the farmer
Digital camera	Visualize the farm and the innovations
Voice recorder	Capture detailed information and verify the drawings
Open evaluation	Find out farmers' perceptions on the participatory documentation of their innovations

Source: Elaborated by the author

Furthermore, the farmer was introduced to the use of a digital camera to enable him to take pictures of all important details from his point of view. Additionally, pictures were taken by the facilitators. In the end, an *open evaluation* of the documentation activities was done with all participants. The results were captured in a diagram.

Notes on the farming system and socio-cultural aspects were taken. They were given by the farmers during informal talks on the day of the first identification visit and the day of the documentation.

### **3.3 Data analysis**

For the description of the innovation process and innovations in harvest storage from the farmers' point of view and to find out farmers' perceptions on the innovation process and on the importance of the innovations in the farming activities, the results of the participatory documentation were analyzed. Digital pictures were taken of all drawings and matrices made during the documentation. Written information from the flip-chart sheets was transcribed and translated by the author into English. Most tables shown in the results are directly translated transcripts from the flip chart sheets. The recorded farmer statements were transcribed and translated by the PES agent from Quechua into Spanish and later translated by the author into English. The transcripts were then reviewed for information complementary to the topics covered in the participatory documentation, for instance, for the description of the innovation process.

Written records of the farmers' explanations on their drawings and information given during the joint farm walk, as well as the results of informal talks with the farmers and PES agents were included in the results to enrich the description of the innovation process and the innovations.

For the interpretation of the achieved positive impacts on harvest storage by using the improved silo, additional to the information given by the Pintos family, documented results from the Malmas' experience were taken. Since the Pintos family had only recently finished building their new silo, the information they gave about the improvements can be regarded as expectations only.

### **3.4 Problems and constraints**

As there was limited access to the community, time was short to create closer and confident relations with the farm family. The language barrier led to limited direct verbal interactions between researcher and participants. During the first visit to the farm, the

level of literacy of the participants to adapt the selected tools was not investigated. The PES agent, who attended the documentation as translator and facilitator, had a good relationship with the family, but little practical experience with participatory documentation. The women were little involved in the documentation activities. The fact that participants were unassertive and not very forthcoming with explanations and opinions constrained especially the evaluation; hence, few comments were made.

At first it was intended to make a qualitative content analysis of the semi-structured interview to gain more information on the farmers' perceptions of the innovation process and innovations. This became impractical, however, since the interview was made in Quechua and the translation was not available in time.

For the study, it was necessary to translate the farmers' statements from Quechua into Spanish and then into English. Therefore, direct quotations of the statements were avoided in the results section.

## **4 RESULTS**

The presentation of the results of the case study is divided into four sections. The first section consists of descriptions of how the farmers selected for the case study were identified and of the farmers' perceptions of participatory documentation. In the second section, the results of the farmers' descriptions on the farm, details on production conditions and socio-cultural aspects as well as the progress and constraints on the farm are shown. In the third section, a description of the innovation process in post-harvest conservation is given. In the last section, actors involved in the case innovation process and their interrelations are described.

### **4.1 Identification and documentation**

#### **4.1.1 Identification of the farmer innovators**

The identification of the farmer innovators and their innovations was conducted by the FAA in cooperation with PES. As the PES agents work directly within the local community context, the cooperation with the local NGO was part of the strategy to identify farmer innovators for the documentation of their experiences. The two partner agents originate from the same communities having not only well-founded scientific, but also local agricultural knowledge; thus, the relation to the community members is based on partnerships. The PES agents acted as key informants seeking farmer innovators and their innovations.

During a first visit on the farms identified by the PES agents, the farmers explained their innovations and they were introduced to the idea of documenting their experiences. The aim was to initiate a process of knowledge diffusion through the elaboration of radio programs for the local farmer radio station and handbooks with visual and written explanations on their experiences.

Seven farmers were visited to determine whether their practice was suitable for documentation and diffusion among other farmers. The following criteria were used as a field manual to identify innovations (PIEPENSTOCK et al., 2006).

Their practice had to:

- Be successful and with short- to medium-term impact
- Be easy to replicate
- Be based on local experiences
- Offer solutions for actual problems of the small-scale farmers of the region.

While the author visited the farm of the Pintos family the first time, the farmer showed and explained his farm. It came out that he was realizing more than one innovative activity on his farm (post-harvest storage, fruit trees and reforestation). A first contact dialogue was carried out to explain the idea of documenting local innovations using a participatory approach and to find out whether he was interested. It was also underlined that the documented material would be used to create radio programs for the local radio station and to edit handbooks for diffusion of his experience. Appointments were made for the day of documentation and the other identified farmer (Mr. Malma) was invited to join the documentation.

Mr. Malma was invited because he showed an innovative behavior, which was also reflected in the way he managed his farm. He had constructed an improved corral for his sheep stock, being inspired by ideas from farmer-to-farmer exchange in another department (cf. Annex 2a) and he was strongly active in terracing his fields for soil conservation purposes.

From the beginning, the farmers liked the idea of documenting their activities and they were proud of their experiments and achievements.

#### **4.1.2 Farmers' perceptions of participatory documentation**

The final evaluation of the documentation activities gave the participants the opportunity to express their impressions on the participatory documentation activities (Box 1). They explained that they were stimulated to reflect on their work and to think about new matters. Several times they noted that the documented knowledge remains as a heritage for future generations (especially their children).

Moreover, the farmers compared the documentation with trainings on farming practices organized by the local labor union. The trainings were described as little motivating, and the on-farm documentation on family level was perceived as more helpful and reasonable.

**Box 1:** Farmers' comments on documentation

We have learned a lot.

The approach was new to us.

Documentation makes us think about new things.

The documentation remains as heritage.

Usually there is no training on family level.

In the labor union sometimes the motivation for training is low.

It is very good to document on family level.

Although I am illiterate, my daughter helped me to understand.

Source: Transcribed comments (original see Annex 7)

Mr. Pinto mentioned that, although he is illiterate, he was able to follow the documentation activities because his daughter helped him in reading the text noted on the flip-charts. The researcher inquired to find out if the participants could imagine keeping on documenting their experiments and innovations on their own. One single answer was given: "In practice, I hand over my knowledge to my children even without documenting".

## 4.2 Farm and production conditions

### 4.2.1 Description of the farm

Information on the Pintos family farm was taken from the resource map and from explanations given by Mr. Pinto (Figure 2).<sup>6</sup>

The farm's size is around 10 ha including arable land for crop production, fruit tree plantation, forest areas and natural pasture sites for animal grazing. It is located on a hillside and some fields are located on very steep slopes. Some plots are terraced with a robust and strong-rooting perennial grass (*Phalaris tuberculata*) similar to the well-known elephant grass. Source for irrigation water is a small stream which carries water in the rainy season, but regularly dries up during the dry season. Self-made sprinkler irrigation is used on crop fields and the fruit trees are watered with a simple tube system, using the natural gradient of the river. As there is no water tank to capture irrigation water in the rainy season, crop production is limited to the period between October/November and April/May. There is a compost site for plant residues and cattle dung. Mineral fertilizer is not applied. Field work is done manually and with animal draft power.

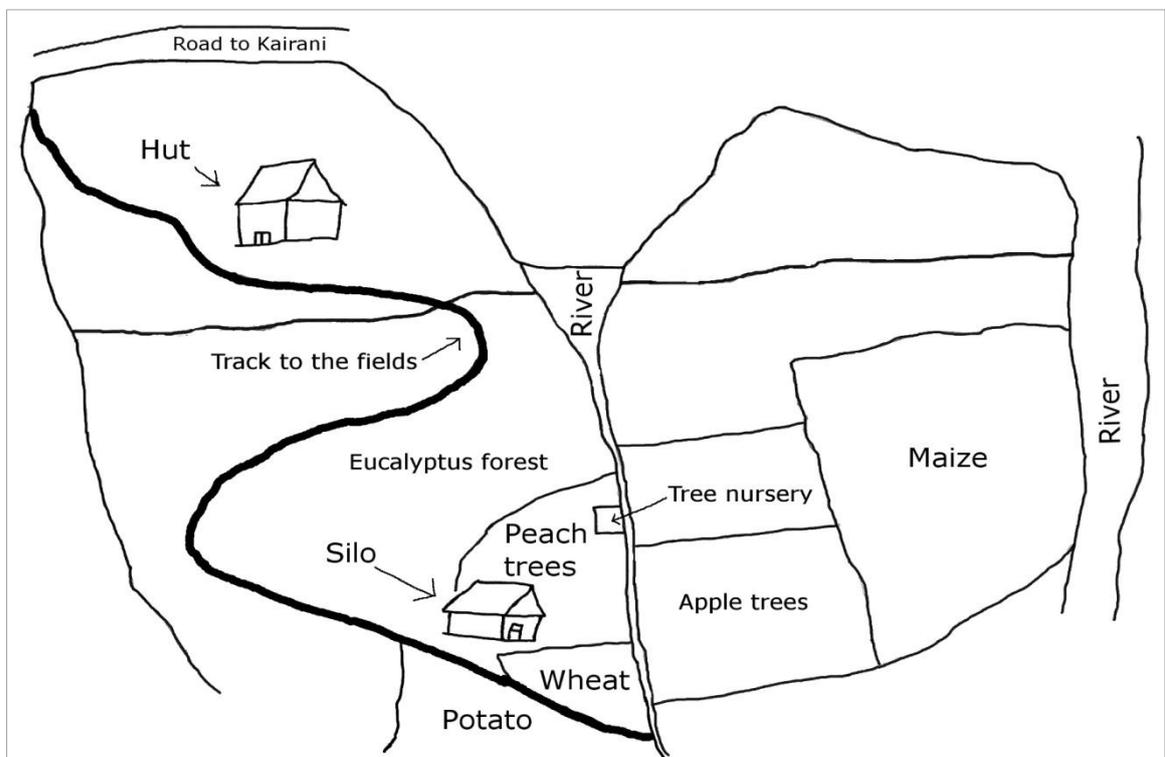
The main cultivated marketable field crops are potato, maize, wheat, field bean and peas. Cultivated vegetables are lettuce, onion and chili for family consumption (Annex 3). There is a peach plantation with around 50 trees and a plantation with 10 apple trees which were planted two years ago (recently, peach production reached marketable quantities, while the apple trees are not producing yet). Furthermore, a pine and cherimoya (*Annona cherimola*) tree nursery has been established in the framework of a community-based forestation program. Within the farm area, there is a small forest with big eucalyptus trees and some natural shrub land.

Livestock keeping plays an important role on the farm. There are cattle (7 for milk and meat production and 1 ox for plowing), 10 chickens and a pig (Annex 3). During daytime, the cows are herded on the surrounding rangelands; at night, they are kept in a corral.

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<sup>6</sup> For transcribed detailed information, see Annex 3

Figure 2: Farm and resource map



Source: Drawing by Mr. Pinto and daughter (above), Simplified and translated draft by the author (below)

Because of the high variability in fodder availability throughout the year, residues from maize plants and phalaris grass are used as additional cattle feed in the dry season.

Products which are brought to the market and are trucked within the community are potatoes, maize, wheat, field bean, milk and sometimes meat. In the community, there is one truck available for transporting the products to the market.

#### **4.2.2 Socio-cultural aspects**

The farm is run by a smallholder family<sup>7</sup>. The household is composed of two generations; the parents live with their four children (ages: 3, 5, 14 and 18 years). They belong to the indigenous Quechua-speaking population. Mr. Pinto and his 14-year-old daughter understand some Spanish; the other family members speak only Quechua. Wealth differentiation in the community is relatively little, but the family belongs to the lower wealth class. In the community, there is a primary school, where the children go to school; Mr. and Mrs. Pinto do not have any formal education. They live in two small huts made out of loam bricks. All adult family members (the parents as well as the eldest daughter and son) are involved in the farm activities. Parts of the farm production are used for consumption, but the monetary income also mainly comes from selling the farm products. Throughout the dry seasons, when income and stocks decrease, Mr. Pinto temporarily migrates to the humid tropical Chapare region to work as a farm laborer. Due to long periods of being separated, and when the wife remains at home with the children, sometimes with insufficient money to buy food, social disharmony arises frequently within the family.

#### **4.2.3 Progress and constraints**

There are a number of major difficulties determining the production and the socio-economic circumstances of the family (Table 3). In production, limited water availability during the dry season, pests and diseases in crop production as well as deforestation and erosion were mentioned by the participants. The economic constraints are the risk of

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<sup>7</sup> Information in Section 4.2.2 was gathered during informal talks with the Pintos family.

harvest losses caused by droughts and frost and low market prices for agricultural products. Furthermore, it was stressed that better income opportunities in urban areas negatively affect the farm activities because of seasonal migration. The unwillingness of sons and daughters to stay on the farm and to take part in farm activities is a related problem. They prefer moving to urban regions to do something different. The fact that the children have little knowledge about farming and that they are not interested in learning more about it was underlined by Mr. and Mrs. Pinto.

**Table 3:** Progress and constraints on the farm

<b>Constraints</b>	
<b>Production</b>	<b>Socio-economics</b>
<ul style="list-style-type: none"> <li>▪ Pests and diseases</li> <li>▪ Limited production cycle</li> <li>▪ Droughts</li> <li>▪ Expensive agrochemicals</li> <li>▪ Erosion</li> <li>▪ Deforestation</li> <li>▪ Burning</li> </ul>	<ul style="list-style-type: none"> <li>▪ The youth do not stay in the community</li> <li>▪ Daughters and sons do not have knowledge on farming</li> <li>▪ Daughters and sons do not like farm work</li> <li>▪ High risk of harvest losses caused by frost and drought</li> <li>▪ Better incomes in the cities</li> <li>▪ Low prices for agricultural products</li> </ul>
<b>Progresses</b>	
<b>Production</b>	<b>Socio-economics</b>
<ul style="list-style-type: none"> <li>▪ Self-sufficiency for consumption (maize and wheat)</li> <li>▪ Soil conservation</li> <li>▪ Cultivation of field bean for better income</li> <li>▪ Apple trees for alternative source of income</li> </ul>	<ul style="list-style-type: none"> <li>▪ Less migration</li> <li>▪ We keep on learning new things</li> <li>▪ With good production, progress is secure</li> <li>▪ Livestock is a good alternative when there is no crop production</li> </ul>

Source: Adapted transcript (original see Annex 5)

In terms of achieved progress to improve the farm situation, Mr. Pinto pointed out the expectation that, by cultivating field bean and producing apple, additional income sources may be generated. Moreover he described seasonal migration to be decreasing as a result of improved livestock management to overcome bottlenecks in crop production.

Recent changes in the production system are activities for soil conservation (terraces and forestation) (Annex 1a), planting peach and apple trees, breeding seedlings in the nursery and some cultivation of vegetables in the homegarden.

Mr. Malma mentioned the importance of the improved post-harvest storage for the self-sufficiency in maize and wheat production for family consumption.

### **4.3 Innovation in harvest conservation**

In the study region, grains and potatoes are traditionally stored in simple bins (*span. troja*), made out of loam and thatched with straw or within the farm houses (PDM Pojo, 2008). The harvest is stored on the bare ground or in bags. Usually, the troja has no door or just small openings in the wall permit the farmer (or the farmwoman) to put in and take out the crops.

Both farmers described the characteristics and effects of storing the crops in the troja as followed (see also Table 4 in Section 4.3.1): absence of ventilation and high heat accumulation lead to fast emergence of pests, fungi and even rodents, which reduce the possible storage time. Seed potatoes are in danger of fast germination and deterioration because of high temperatures. The productivity of seed potatoes was described in a quantitative ratio of 1:3 between seed potatoes and harvest. The effects of short storage time (constraint for speculating on the best market price), post-harvest losses and product quality (decreasing quantity and quality of marketable products) have an important impact on the economic situation of the family and for the availability of produced food for self-consumption (Annex 1b).

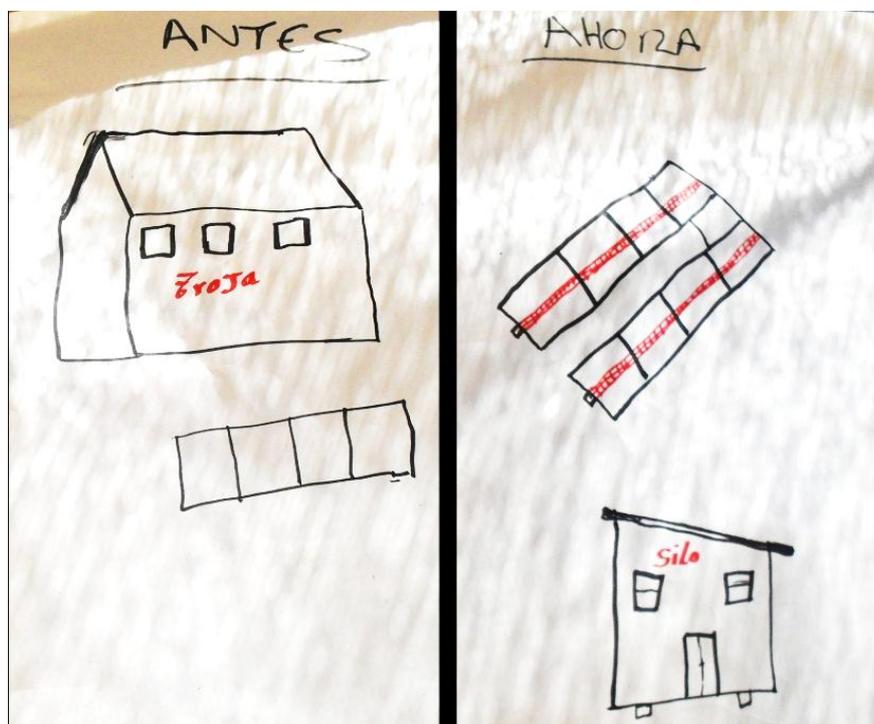
To improve the conservation quality of grains and seed potato, a new silo was planned and constructed on the farm. The following sections bring a description of the silo and comparison with the *troja*. Moreover, the innovation process and the involved actors are presented.

#### **4.3.1 Description of the silo**

The silo has a foundation of concrete and looks similar to the typical farm-houses of the region (shape, size, material). It has a door entrance and a small walking corridor in the middle. On each side, it has three storage compartments with a lengthwise duct in-ground for natural wind ventilation. Walls are made of self-made loam bricks and the

compartments out of conventional bricks, plastered on the inside with cement. The roof is thatched with corrugated iron.

**Figure 3:** Troja and silo compared



Source: Drawing by Mr. Pinto

Figure 3 shows a schematic drawing of the *troja* and the silo. It can be seen that the *troja* already had compartments with small windows. The ground plan of the silo shows the corridor with compartments on each side and the ducts (red color) with exits on both sides.

The advantages of the silo over the *troja* are listed in Table 4. The ducts under the compartment regulate the temperature inside the silo with air from outside. The foundation made of concrete provides a cold basis to put the stored items on. The crops are better protected from pests and fungi, and can be stored for a longer period of time.

Mr. Malma experienced that the quality of stored seed potatoes is much better. He said that, because of lower temperatures in the silo, the potatoes germinate slower and produce higher yields (see also Annex 2c). Moreover, he pointed out that the ability to store the grains for a longer period led to increased self-sufficiency in wheat and maize.

**Table 4:** Traits and their effects of the two storage facilities

	Troja	Silo
<b>Trait</b>	Closed, no ventilation	Better ventilation
	Heat concentration	The foundation cement is cold
	Emergence of pests and fungi (grain: <i>Sitophilus spp.</i> , potato: <i>Phthorimaea operculella</i> )	No emergence of pests
<b>Effect</b>	Storage for short time (grain: ~3 months, potato: very short time)	Storage for longer period (grain: ~1 year, potato ~3 months)
	Disposal forced by deterioration of harvest	
	Insufficient for self-consumption	Possible self-sufficiency for wheat and maize
	Faster germination of seed potatoes caused by heat	Seed potatoes germinate slower Produces more
	1 bag of seed potato yields 3 bags of harvested potatoes	1 bag of seed potato yields 10 bags of harvested potatoes (same variety)

Source: Transcribed comments on Figure 3 (original see Annex 6)

### 4.3.2 Construction process

Mr. Pinto built most parts of the silo. He possessed the required knowledge to work out the basic construction, since the foundation and walls were built in much the same way as traditional buildings are constructed. In defining the position of the silo with regards to the wind for ventilation, he also used his knowledge on local wind conditions (explanations given by Mr. Pinto on Figure 2, page 35). Results of the *timeline diagram* with construction details step-by-step can be found in Annex 4a and 4b.

Mr. Pinto stated that he had never seen this type of silo before and that the PES agent gave him the idea. He highlighted that the construction plan was made together with the PES agents and that he then started to build it on his own. Furthermore, he said that he agreed with the idea to make a silo because he had some loam bricks already made (Annex 1d).

To build the storage compartments inside the silo, a brick layer was hired by Mr. Pinto. The external material and costs are listed in Table 5. It is shown that expenses for construction material and external labor are fairly high. In order to compare the given values: 1 hour for agricultural labor in the region costs about € 4; 100 kg of potatoes has an approximate market price of € 23 (FAO, 2009).

**Table 5:** Construction costs for the silo

Item	Cost [Boliviano]	Cost [Euro]
Corrugated iron (roof)	1119.00	116.94
Concrete (644 kg)	770.00	80.47
Conventional bricks (400 pieces)	520.00	54.34
Welding of iron gratings	400.00	41.80
Iron gratings (ducts)	360.00	37.62
Labor (brick-layer)	360.00	37.62
Construction sand	200.00	20.90
Timber for roof construction	180.00	18.81
Iron wire	90.00	9.41
Wire mesh for windows	45.00	4.70
<b>Total</b>	<b>4044.00</b>	<b>422.60</b>

Source: Transcription of material and costs (exchange rate 9.11.2011: 1Euro = 9.57 Bolivianos)

Constraints that arose were Mr. Pinto's temporary migration to the Chapare region, difficulties in obtaining external materials delaying construction, and difficulties in obtaining enough money to pay the brick-layer's salary (Annex 4b). The construction lasted in total from April 2010 to December 2010. Details about cost sharing between PES and the farmers are given in Section 4.4.

**Figure 4:** The improved silo



Source: Picture by the author: Mr. Pinto in front of the new silo (above), compartments with potatoes (l) & duct (r)

### 4.3.3 Lessons learnt

The participants in the documentation reported a number of aspects they learnt from the innovation (Box 2). They were able to generate knowledge on seed potato quality management and on how to improve the sanitary conditions of their crop storage facilities to protect the harvest from pests, fungi and rodents. Moreover, they acquired abilities in construction planning, for instance, the importance of the silo orientation to ensure adequate ventilation, the design of storage compartments and ducts and the calculation of the project's costs. They have also become aware of how the silo contributes to improving the families' self-sufficiency.

#### Box 2: Lessons learnt in the innovation process

##### Seed quality:

- Acquisition of knowledge on seed quality
- Control of seed quality

##### Improvement of storage conditions:

- Protection of the harvest from rodents
- Improvement in sanitary and cleanliness conditions
- Ventilation of storage facilities

##### Construction:

- Design of storage compartments and ducts
- Calculation of costs

##### Self-sufficiency:

- Extension of the storage time for relevant products for family consumption

Source: Adapted from the comments given by farmers (original: see Annex 7)

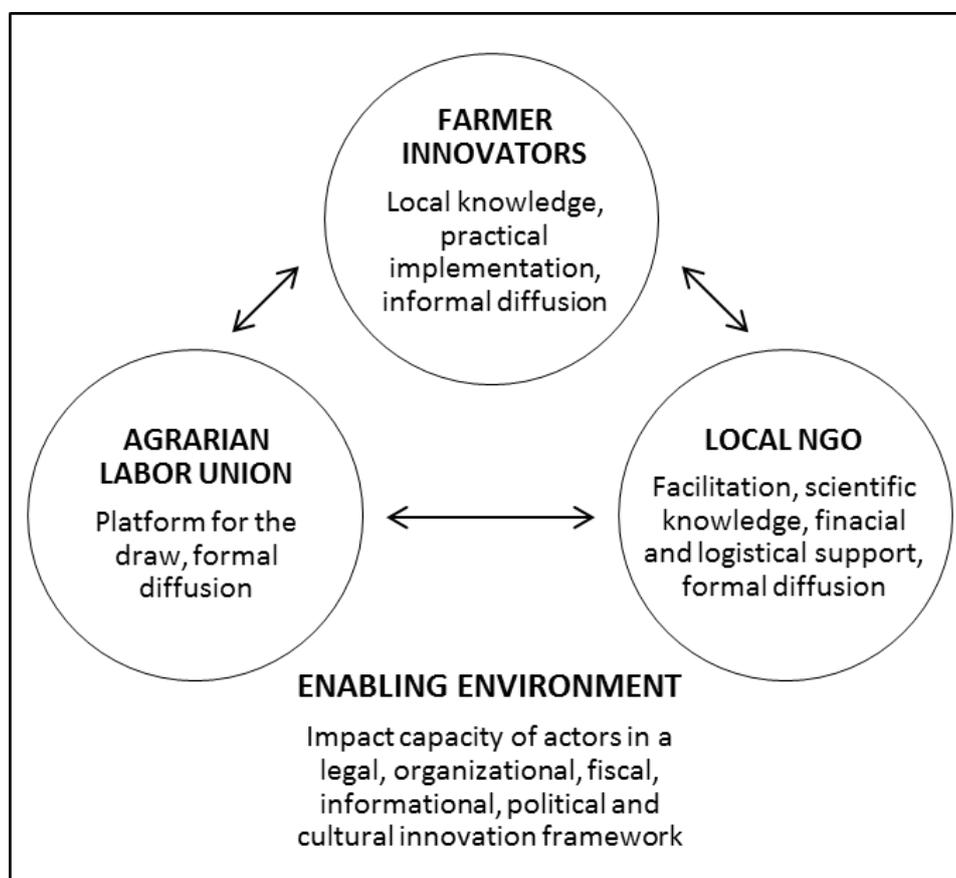
### 4.4 Actors involved in the innovation process

The description of the initial innovation process was given by Mr. Malma (Annex 2b) and applies for both families, since the conditions were very similar in both cases.

Initiated by the local agrarian labor union in cooperation with the PES, a draw was carried out among farmers. Almost all the farmers in the district belong to the agrarian union

(PDM Pojo, 2008), but the participation in the drawing was restricted to farmers who were realizing soil conservation techniques on their farms. In 2009 and 2010, one farmer each was selected to be supported. The PES provided the funds for construction material and they provided technical as well as logistical support. Apart from putting their manpower for the construction, the farmers had to pay for the external labor (brick-layer). Mr. Malma was selected in 2009 and Mr. Pinto in 2010.

**Figure 5:** Local innovation - actors and their functions



Source: Elaboration by the author

Figure 5 shows the actors involved and their tasks in the innovation process. The farmer innovators can be seen as contributors in the process. Their local knowledge ensured that the project could be carried out (technical knowledge: e.g. techniques for making loam bricks and constructing traditional houses, knowledge on specific local conditions, e.g. wind conditions and sources of local material). They were protagonists of the practical implementation and can be seen as potential multipliers in the informal diffusion among other farmers. The PES agents are the main actors in facilitating the process. They

contributed with scientific knowledge and financial as well as logistical support. The local agrarian labor union took the leading role in carrying out the draw. Both the NGO (PES) and the labor union are potential actors in the formal diffusion and adoption process.

## **5 DISCUSSION**

In this chapter, the case study results on methods of identifying and documenting local innovation are examined and put into the context of the findings from the literature review. Moreover, it is discussed how the innovation can be defined and classified. To conclude, an interpretation of the farmers' perceptions on the innovation process, innovations and participatory documentation is given.

### **5.1 Identification and documentation methods**

#### **5.1.1 Identification**

First of all, the selected identification criteria for the innovation described in Section 4.1.1 have to be discussed (successful, having short- to medium-term impact, easy to replicate, based on local experiences, offering solution for actual problems).

The criteria can be regarded as useful in the present case, because the PES agents already knew the farmers, innovations and the local context before. They were able to assess the innovation and compare it to the given criteria. For actors (researchers, extension agents etc.), who are unfamiliar with the particular locality, it may be difficult to rely on the selection criteria only and to know what is "unusual" (cf. HAILE et al., 2001) in a locality, when trying to identify local innovations without support from local key informants. Accordingly, the cooperation with local insiders is crucial for the identification of local innovators and innovations. In addition to that, the conversation with the farmers while visiting their farms can be seen as an important source of information to make sure the innovation fits the selection criteria and to find out how farmer innovators assess their innovations with respect to its relevance for other farmers.

Regarding the role of the local NGO, the identification method applied in the case study has to be challenged. The PES agents acted as local key informants. The fact that they selected the visited farms leads to the question whether their prime intention was really to identify the most innovative farmers whose innovations have a high impact on the local development of smallholder agriculture in the region or to select farmers that have already been supported by PES to use the documentation for institutional promotion

purposes. Similar observations on NGO agents who are hardly able to recognize local innovators and innovations, since they are focusing on innovations related to their support activities, are described by REIJ & WATERS-BAYER (2001a). An alternative to identification activities conducted by NGOs might be the potential of farmers and their local organizations (e.g. labor unions, cooperatives etc.) to take the leading role in identifying local innovators and innovations that are not being supported by extension services.

The present case can be described as a directed identification process. The purpose was not to identify a high number of innovations in the region, using a combination of several identification methods (Section 2.2.4), but rather to identify only few preselected innovations for documentation in the framework of an extension project with the aim to publish diffusion material (leaflets, broadcasts etc.). The selection sampling in the region does not assure representation of the regional mean of local innovations (cf. NIELSEN, 2001), since the selection was not done at random. The random selection would be an important identification approach for research to find out a mean of local innovations in a defined area that would represent the innovation activities of a local population, also avoiding the risk to identify only the “projects pets” (CRITCHLEY, 2000), farmers who have been supported by NGOs and who may “repel rather than attract” (CRITCHLEY, 2000) other farmers in the process of the diffusion of a local innovation.

Implementing the case study (identification and documentation activities) meant a high workload for the participants and required certain financial inputs from FAA and PES, for instance, logistical costs for realizing field visits were costly, especially for the FAA, as long distances had to be covered; three working days had to be spend with two PES and one FAA agent for identification and documentation activities in Pojo District. Therefore, identification activities have to be realized in an efficient manner (preferentially by local actors to reduce logistical costs), selecting the best innovations to document, considering their relevance for enhancing local innovation processes in the development of smallholder agriculture, especially to provide motivating examples to foster the innovative behavior of other farmers (cf. FRIIS-HANSEN & EGELYNG, 2007). Bearing in mind

the relevance of an innovation from the adopters' point of view, farmers and their organizations should be strongly involved in the identification process.

### **5.1.2 Documentation**

The review of the literature on participatory documentation revealed that there are a number of approaches to document innovation processes and innovations with farmers. One main challenge faced in the case study was to select the right tools to fit the local context; for instance, the importance of identifying the literacy level of the participants in advance (Mr. Pinto was able to follow the written comments on the flip charts only with his daughter's help).

The farmers' perceptions on the participatory documentation indicated that the approach was new and somehow it was difficult for them to relate to it. The farmers initially appeared to be reluctant to take part in the documentation activities. It seems difficult to bring together farmers' practical working routine and experimentation with the theoretical approach of documenting their work. This may be caused by the fact that farmers somehow feel inferior to researchers and extension agents or may be for semantic and conceptual reasons (language, worldview), as was also noted in a study conducted by SIMPSON (1999).

Despite this, the farmers noted that the documentation activities helped them to reflect on their work and to learn new things. This can be regarded as an interesting additional function of the participatory documentation (cf. Section 2.2.5). Besides sharing the experience with other farmers, the farmer innovator himself makes use of the documentation to reflect on and evaluate his work.

In the case study, the joint documentation with two farmers who have similar innovation experiences underlines the function of joint reflection and exchange of ideas and experiences between innovators, since it was mentioned by the participating farmers to be beneficial for them. Furthermore, this helped to draw a more complete picture of the local innovation for the diffusion material.

Reflection on the facilitation of the participatory documentation activities revealed that facilitators have to be highly skilled in applying the participatory tools. Above all, didactically important points such as conveying the background and purpose of the documentation approach and the facilitation of participatory drawing activities are crucial for successful documentation. This means not only extracting information for diffusion material but also using the documentation as a learning process for all participants.

## **5.2 Defining and classifying the innovation**

To put the innovation in the context of definitions from the literature (cf. Section 2.2.1) the level of external inputs in terms of knowledge and motivation as well as technical and financial support has to be examined. Bearing in mind the role of the local NGO and the labor union in the innovation process, it has to be questioned if the innovation can be defined as local, since the initial idea and technical as well as financial support was given by the local NGO. Farmers received direct support from outside and the innovation is not based on the use of only local resources (cf. definition by WETTASINHA et al., 2008 in Section 2.2.1).

Mr. Pinto stated that he made the construction plan together with the PES agents. This leads to the suggestion that he gave own inputs into the design and adaptation of the silo but, no deeper information was given to prove this. The fact that he was participating in the innovation process and that he internalized external knowledge shows that it is not a case of “mere adoption of techniques promoted by an NGO” (CRITCHLEY, 2000), but rather a “subtle adaptation” (CRITCHLEY, 2000).

The newness of the innovation to the locality was proven (cf. PDM POJO, 2008) but, in a global context of improved long-term crop-storage techniques, similar inventions can be found in the literature (e.g. PROCTOR, 1994; AIDOO, 1993).

According to the classification of innovations in the literature (cf. Section 2.2.3), the innovation in this case is a *technological innovation* related to the *process* of conserving and storing agricultural products. Regarding the cooperation of farmers, NGO and labor union to create a basis for local innovation processes (cf. Section 4.4) it can be assumed that some degree of *institutional innovation* is also involved. There is no evidence about

the newness of the way the actors worked together, but reviewing former PES projects (e.g. on soil and water conservation) it becomes evident that farmers were usually little involved in innovation development activities. Furthermore, the PES agents had no experience in applying participatory documentation and diffusion approaches and their willingness to introduce them into the NGO's working profile indicates some degree of *institutional change*. The interaction of the different actors to foster local innovation can be regarded as an initial situation of joint experimentation (cf. description of the PID approach in Section 2.1.4).

For further analysis of the functioning of the institutional framework to enhance local innovation processes, the role of the enabling environment (cf. Figure 5 in Section 4.4) would still have to be determined. It is likely, for instance, that the political, legal or cultural framework has a high impact on the sustainability of local innovation processes for the development of smallholder agriculture. These aspects could not be covered during the brief period of the case study.

### **5.3 Innovation process and innovations**

Triggers and driving forces of innovation can be found by interpreting the information given by the farmers on the farm situation and achievements/difficulties in the farming system (Section 4.2). It emerges that an important trigger seems to be the confrontation with difficult production and marketing conditions (droughts, frost, erosion, seasonally limited rain fed crop production and low market prices for agricultural products). The necessity for self-sufficient grain and potato supply for family consumption was underlined several times. However the explanation on different modifications and experiments (fruit trees, reforestation, home garden for vegetables) given by the farmers reveals their strong enthusiasm for innovation. This enthusiasm can be seen as a driving force, induced by creativity and encouraged by the feeling of success (cf. Section 2.2.2).

With regards to the innovation in crop storage, opportunistic behavior can be assumed because the farmer responded to the offer from the local labor union to participate in the draw for receiving support for constructing a silo. It can be deduced that triggers and driving forces of local innovation are rather multi-causal.

The description of the innovation process given by the farmers shows that they were already experimenting with alternative practices like soil conservation, reforestation and vegetable gardening before they started the project of improving their crop storage. The initial idea for the construction of the silo was given by the local NGO (PES), but farmers took an important role in the planning activities to adapt the innovation to their specific conditions. They enriched the process with their local knowledge on traditional construction and local material, putting the innovation into practice on their own initiative and with their own manpower. Furthermore, they paid for the external labor needed. From their explanations, it became obvious that the farmers felt themselves to be protagonists of the planning and construction process.

They claimed to have gained new knowledge from the innovation process (e.g. ventilation techniques and calculation of costs). This information came mainly from external sources and was enriched by the farmers' local knowledge. Accordingly, the internalization of the external information in interaction with local knowledge can be considered as the trigger for new knowledge creation.

The experiences described by Mr. Malma on how he tried out different ways of storing seed potato to improve quality show how he started to experiment. He compared the harvest quantities from seed potato that had been stored in the troja and in the improved silo. This experimentation gave him evidence that seed potato quality depends on the storage conditions and that he is able to control seed quality to increase production.

From the farmers' explanations on the impacts of the innovation on crop storage and the farm situation, it was apparent that they expect to increase substantially their production through the new silo. Their comparison on the troja and the silo (Table 4 in Section 4.3.1) shows an intensive examination of the advantages of the new construction and its potential impacts. Negatively noted aspects of the new silo which can be interpreted as potential constraints for the diffusion of the innovation are the high proportion of external construction material (costs and availability), the lack of concrete evidence of advantages in comparison to traditional harvest storing techniques and the lack of some skills required for the construction.

As the silo was built recently, long-term impacts on production and self-sufficiency in maize, wheat and potato for family consumption and possible problems with the new silo need to be further analyzed and evaluated.

## 6 CONCLUSION

The present study gives an overall picture on an identified and documented case of innovation in post-harvest storage facilities in smallholder agriculture in Cochabamba, Bolivia. From the examination of the innovation process, questions arise about the local character of the innovation, as there was a strong involvement of local extension agents in the innovation process. The approach applied to identifying innovations was not successful for identifying local innovations that are developed by farmers without external support. It can be concluded that local partners (in this case, the NGO) with knowledge on the local conditions are crucial for the identification, although they tend to focus on innovations that were developed with their own support.

As the farmers' acceptance of the innovation and their initial expectation on the improvements that the innovation allowed were high, the joint innovation development with extension agents shows promise to contribute to the development of smallholder agriculture. Furthermore, considering the farmers' innovative behavior, the initial support from the extension service may foster the confidence of farmers to be able to change their situation by experimenting with new ideas. Moreover, it becomes evident that an innovation for smallholder farming should not depend greatly on costly external inputs, since farmers described these traits as negative and this could hamper the adoption of the innovation by other farmers.

About the innovation framework, the interactions of the actors involved in the innovation process show that institutional innovation may contribute to the enhancement of local innovation processes. The ongoing diffusion and adoption process of the case innovation and its potential to provide an example for promoting innovative behavior among other farmers within the community and in the region is still to be analyzed.

Reflecting on the set-up and the results of the present study reveals some limitations and allows some observations. Comparing the research aims and the respective findings with studies reviewed in the literature, it becomes clear that similar findings have already been made in other contexts. As local innovation processes are closely linked with specific socio-cultural and biophysical conditions that are highly variable in diverse agricultural

systems, the present case study provides a “local” contribution to understanding innovation processes in a region where little research has been conducted on this topic.

The participatory documentation approach was designed in this study for application in practical development contexts to exchange and spread innovative ideas. The case study showed that this form of documentation can be regarded as a personal learning process for farmer innovators to analyze and evaluate their innovations. The farmers’ perceptions on the participatory documentation prove the importance of designing the documentation tools and facilitation to fit the particular background of the participants, since it was difficult in this case to involve illiterate farmers in the documentation activities. For the examination of local innovation processes on a scientific level, the participatory documentation approach is not deeply explored. However, the results of the case study suggest that the approach is suitable for describing local innovation processes from the farmers’ perspective, rather than for empirical analysis of local innovation.

Further research is needed, especially to go further into the knowledge on potentials and limitations of local innovations to be adopted by other farmers into ways to create a culture of farmer innovation in smallholder agriculture.

## 7 SUMMARY

In smallholder agriculture, innovation is the driving force for the improvement of farming systems and for the development of adoption strategies to cope with constantly changing production and marketing conditions. Building on the evidence that farmers have always been experimenting with new ideas and practices to bring out locally adapted innovations, a number of approaches have been established to understand and support the important potential of smallholder farmers as innovators and to give an answer to the failure of classical top-down innovation models. These approaches provide participatory methods to identify local innovators and their innovations, to document the innovations and to facilitate their promotion and diffusion.

In the present study, the literature is reviewed on different approaches to understanding and supporting local innovation with the aim to situate local innovation processes and concepts in the context of agricultural innovation models. Moreover, a case of local innovation in post-harvest storage on a smallholder farm in the central Andean region of Cochabamba, Bolivia was documented with a participatory documentation approach to draw an overall picture on how the innovation process and the impacts of innovations on the farm situation are perceived by the farmer innovators and to explore interrelations and functions of involved actors in the innovation process. Furthermore, the case gives an insight into farmers' perceptions of the participatory documentation and examines the methods applied in the process of identifying the farmer innovators.

The study results show the importance of selecting multiple methods to identify local innovation, involving actors in the process who are familiar with the local context. Participatory documentation is perceived by farmers as a learning process for evaluating their work and sharing their innovations with others, despite the difficulty to bring together farmers' practical working routine and experimentation with the theoretical approach of documenting their work. Farmers responded positively to the joint innovation development with external support, which shows potential for institutional changes in interrelations and attitudes of extension services, researchers and farmers' organizations towards participatory strategies for the support of local innovation processes in the development of smallholder agriculture.

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## 9 ANNEX

### 9.1 Annex 1

#### Translation of transcript with statements from Mr. Pinto:

Participatory documentation 16th December 2010, Community Duraznillo, Pojo.

a.) *The important thing is to improve the reforestation and soil conservation because before there was no vegetation. Now that there is vegetation there is no more erosion.*

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b.) *Before in the troja (traditional silo) there was no ventilation and the gorgojo [a.n.: Sitophilus spp.] and pilpinto [a.n.: worms] always appeared. To maintain the family there was not enough time to store the harvest. For the dry period there was nothing left for the consumption of the family because we could store for three month only. We were under constraint to sell the harvest on the market.*

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c.) *Now with the new silo, apparently there is a change because it is cold and open with windows. It has a small corridor and divisions for the different grains and seeds. You can see the change because before the gorgojo and the polilla [a.n.: Phthorimaea operculella] spoiled everything but now as the floor is cold it can be stored a longer time.*

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d.) *I had never seen the construction of a silo before. But the engineer helped me because they saw the loam bricks ready. So we made the construction plan together and then I started to level the ground. As I worked too fast, the cement was not brought in time. Because of the rainy season it was not possible to make loam bricks but as I had some bricks stored for other construction purpose, I started to construct on my own. That is why the silo is ready this year.*

----

e.) *Our place is good to produce field beans, wheat, maize and potatoes, but we lack water. We saw the experiences of other families who do forestation and it opened my eyes: if we cut all the trees to use them for firewood without planting new trees, we will*

*lack of trees. And because outside my farm people still cut trees for firewood, I plant new trees and I have still enough firewood from my own trees.*

## **9.2 Annex 2**

### Translation of transcript with statements from Mr. Malma:

Participatory documentation 16th December 2010, Community Duraznillo, Pojo.

*a.) The experience started with soil conservation activities five years ago. Before, the soil eroded a lot; now the soil is protected and already elevated to 1.5 m. I built my new barn after an experience I saw in Tapacarí. There it was made of stone, but I made it out of loam bricks. The sheep were dying before because of strong wind. The grass [a.n.: Phalaris tuberculata] helps as additional fodder. I have pine trees and I would like to have more forestation because I have still some land to plant trees and I think that forestation is very important nowadays.*

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*b.) The process started in 2009 with a draw within the agrarian labor union members among 17 persons who were practicing soil conservation participated and I was selected because there was only support for one silo. So we started to plan the silo with the engineers. Fortunately I have knowledge in construction so I have built up everything on my own without paying external labor.*

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*c.) The seed potato when stored in the troja produced 3 bags out of 1. Stored in the silo, the germination is slower and out of 1 bag I get 10 bags with the same variety as I used before.*

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*d.) The documentation was very good for us; before we just sowed without evaluating and calculating. It was by chance that we gained or lost, we just did the work without any adjustment. If the potato yield remains as high as this year, I will not move to any place outside the farm to work.*

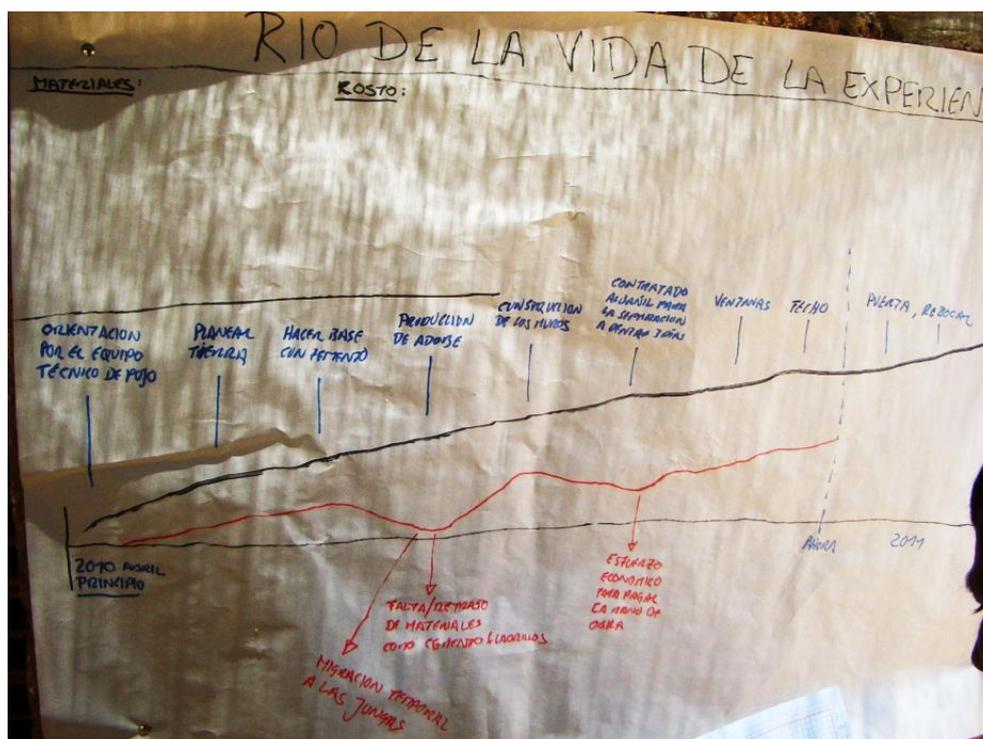
### 9.3 Annex 3

Transcribed information on farm details from the farm and resource map (Figure 2):

Family		Malma	Pinto
Community		Yuthupampa	Duraznillo
No. of family members	Female	6	5
	Male	1	3
Farm size [ha]		6	10
Water supply		Reservoir	River
Livestock	Cows	-	8
	Pigs	-	1
	Sheep	10	-
	Chicken	5	10
Crops	Potato	x	x
	Field bean		x
	Peas	x	x
	Onion	x	-
	Maize	x	x
	Wheat	x	x
	Lettuce	x	x
	Apple trees	x	x
	Peach trees	-	x
	Pine-trees	x	-

### 9.4 Annex 4

a.) Timeline of the innovation process (Mr. Pinto):



b.) Translated transcript of 9.4 a.):

Construction steps (from April to December 2010)	Constraints
Orientation by the extension team Pojo Level the underground Make foundation out of concrete Production of loam bricks (additional) Construction of the walls Hire brick-layer to make compartments inside the silo (3 days) Windows Roof In 2011 the door will be finished	Seasonal migration of Mr. Pinto to the Yunga-region slowed down the process  Missing external material (concrete, bricks) and late arrival of the same  Economic effort to pay external man power (brick layer)

## 9.5 Annex 5

Progress and constraints diagram:

IDENTIFICACION DE PROBLEMAS ANIVEL FAMILIAR

**DIFICULTADES**

PRODUCTIVOS	SOCIALES/CULTURALES	ECONOMICOS
<ul style="list-style-type: none"> <li>• PLAGAS Y ENFERMEDADES</li> <li>• EPocas DE PRODUCCION</li> <li>• SECHILLAS CON ROSARIO</li> <li>• ESCASO DE AGUA</li> <li>• ALONO SON CAPOS</li> <li>• FUNGICIDAS SON CUELAS</li> <li>• PESTICIDAS SON CARIAS</li> <li>• EROSION</li> <li>• DEFORESTACION / QUEMA</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• LOS HIJOS NO PERMANECEN EN COMUNIDAD (MIGRACION)</li> <li>• POCO CONOCIMIENTO DE HIJOS SOBRE MAPO Y LA PRODUCCION</li> <li>• HIJOS NO QUIEREN TRABAJAR EN EL PATIO</li> </ul>	<ul style="list-style-type: none"> <li>• RIESGO DE HELADAS EN LA PRODUCCION DE CULTIVOS (DESASTRES NATURALES)</li> <li>• SECIA</li> <li>• MAYOR INGRESO EN LA CIUDAD</li> <li>• MERCADO (MUCHA OFERTA)</li> </ul>
<b>AVANCES</b>		
<ul style="list-style-type: none"> <li>• MANEJO PARA AUTO-CONSUMO (MAIZ &amp; TRIGO)</li> <li>• CONSERVACION DE SUELOS MANTIENE PRODUCCION</li> <li>• CULTIVO DE AVUEJA DA MEJOR INGRESO</li> <li>• MANZANAS SON ALTERNATIVA PARA MEJOR INGRESO</li> </ul>	<ul style="list-style-type: none"> <li>• YA HAY MENOS MIGRACION</li> <li>• SIGEN APRENDIENDO COSAS NUEVAS</li> </ul>	<ul style="list-style-type: none"> <li>• PRODUCCION BUENA — AVANCE SEGURO</li> <li>• EL GANADO ES ALTERNATIVA DE INGRESO CUANDO NO HAY PRODUCCION DE CULTIVOS</li> </ul>

## 9.6 Annex 6

Comparison of the troja and the silo (see Table 4):

<u>DIFERENCIAS</u>	
<p><b>CONCENTRACION DEL CALOR</b></p> <p>APARECEN LAS PLAGAS (GONGOJO) POLILLA (PAPA)</p> <p>• CERRADO, NO HAY VENTILACION</p> <ul style="list-style-type: none"> <li>• NO SE PUEDE GUARDAR MUCHO TIEMPO → 3 MESES</li> <li>• VENTA DE PRODUCTOS PORQUE NO SE PUEDEN GUARDAR TIEMPO ⇒ NO ABASTECE PARA EL CONSUMO</li> <li>• LA PAPA GERMINA MAS RAPIDO POR EL CALOR</li> <li>• TX 1 BOLSA PRODUCE 3 BOLSAS</li> </ul>	<ul style="list-style-type: none"> <li>• MEJOR VENTILACION</li> <li>• NO APARECEN PLAGAS</li> <li>• EL CEMENTO ESTA FRIJO</li> <li>• <del>IGUAL HAY RIESGO DE PLAGAS</del> (MAIS → gongozo)</li> <li>• CONTROL DE PLAGAS</li> <li>• SE PUEDE GUARDAR MAS TIEMPO</li> <li>• SE PUEDE GUARDAR:             <ul style="list-style-type: none"> <li>• GRANOS = 1 AÑO (PARA SEMILLA o CONSUMO)</li> <li>• PAPA = 3 MESES</li> </ul> </li> <li>• LA PAPA GERMINA LENTA Y DA MAS PRODUCCION</li> <li>• DE 1 BOLSA PRODUCE 10 BOLSAS</li> </ul>

## 9.7 Annex 7

Evaluation of the participatory documentation and lessons learnt from the innovation:

<u>EVALUACION DE METODOLOGIA</u>	<u>APRENDIZAJES</u>
<ul style="list-style-type: none"> <li>• Hemos APRENDIDO MUCHO</li> <li>• AUNQUE NO ESCRIBO, MI HIJO ME AYUDA</li> <li>• HA SIDO NUEVO</li> <li>• NOS HIZO PENSAR EN COSAS NUEVAS</li> <li>• A NIVEL FAMILIAR NO HAY CAPACITACIONES</li> <li>• ES MUY BIEN TRABAJAR A NIVEL FAMILIAR</li> <li>• EN SINOKATO POR EJEMPLO A VECES HAY POCO ANIMO Y PERMANENCIA</li> <li>• LA DOCUMENTACION QUEVA COMO HERENCIA</li> <li>• LO DOCUMENTADO QUEVA Y NO LO LLEVAMOS</li> </ul> <p>SE PUEDEN IMAGINAR DOCUMENTAR SOLOS?</p> <ul style="list-style-type: none"> <li>• CAPACITAR A MI HIJOS EN LA PRACTICA LES DA EL CONOCIMIENTO A ELLOS</li> </ul>	<ul style="list-style-type: none"> <li>• COMO MANEJAR LA QUALIDAD DE LAS SEMILLAS</li> <li>• IMPORTANCIA DE LA UBICACION DEL SILO (VIENTO!)</li> <li>• DISEÑO DEL INTERIOR DEL SILO (CAJAS)</li> <li>• COMO HACER LA VENTILACION</li> <li>• CALCULAR LOS COSTOS</li> <li>• EL SABER SOBRE LA QUALIDAD DE SEMILLAS</li> <li>• GUARDAR COSECHA POR MAS TIEMPO</li> <li>• SEGURIDAD DE AUTO CONSUMO</li> <li>• POR LA FORMA DE CONSTRUCCION CON CEMENTO NO ENTAN RATAS</li> <li>• MAS LIMPIO / MEJOR HIGIENE</li> </ul>

## 9.8 Annex 8

### Documentation schedule:

Time	Activity	Tool
8:00	Welcome and presentation of the program	Explanation
8:15	Introduction to participatory documentation	Explanation
8:45	Drawing activities	Resource map / notes
9:45	Identification of progress and constraints	Diagram
10:30	Innovation process	Timeline of innovation drawing / notes
12:30	Before-after comparison of storage facilities	Drawing and diagram
13:30	Lunch	
14:30	Interview (PES agent)	Voice recorder
15:30	Joint farm walk and photos	Explanations by farmer and camera
16:30	Evaluation	Plenary session / notes

## 9.9 Annex 9

Ich versichere hiermit, dass ich die Arbeit selbstständig verfasst, ganz oder in Teilen noch nicht als Prüfungsleistung vorgelegt und keine anderen als die angegebenen Hilfsmittel benutzt habe. Sämtliche Stellen der Arbeit, die benutzten Quellen im Wortlaut oder dem Sinn nach entnommen sind, habe ich durch Quellenangaben kenntlich gemacht. Ich erkläre mein Einverständnis zur Überprüfung der von mir eingereichten Arbeit auf Plagiate durch eine Anti-Plagiatsoftware. Zu diesem Zweck stelle ich eine anonymisierte elektronische Form des Dokuments in gängigem Format zur Verfügung.

Witzenhausen, den 20.01.2012

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Markus Frank