

# Substitute traditional agriculture in the central valley of Bolivia: the adaptation of agroforestry

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Supervisor: Dr.rer.soc.oec Xiomara-Fernanda QUIÑONEZ-RUIZ

by Alexander GASSER, 01541163

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## **Abstract**

The accumulation of humans, especially in cities and within the need of food security poses innovative forms of agriculture. Extensive cultivation of monocultures in already vulnerable valleys causes only a short-term solution. According to agroforestry the cultivation form aspires welfare among farmers and consumers in long-term. Thus, this thesis consists of two case studies according to the following research question:

How are small-scale farmers learning collectively agroforestry in the central valley of Bolivia? I collected data from semi-structured interviews, document analysis and participant observation during July till November 2017. According to the case study protocol I ensure the logical structure of this paper. Using the International Analysis and Development (IAD) Framework by Elinor Ostrom I will show the various factors of learning collectively agroforestry or not. Aim of this thesis is to deepen the knowledge about agroforestry in Cochabamba and its adaptation through learning.

**Keywords:** agroforestry, Bolivia, collective action, institutional analysis, learning.

## **Resumen**

La acumulación de humanos, especialmente en las ciudades, y la consecuente necesidad de seguridad alimentaria requieren técnicas agrícolas innovadoras. El cultivo extensivo con monocultivo en valles vulnerables es solamente una solución a corto plazo. De acuerdo a la agroforestería, su forma de cultivo asegura el bienestar de los agricultores y consumidores a largo plazo. Esta tesis, a través de dos casos de estudio, abordará la pregunta: ¿Cómo están aprendiendo colectivamente los agricultores de pequeña escala sobre agroforestería en el valle central de Bolivia? Los datos fueron recopilados con entrevistas semi-estructuradas, análisis de documentales y observación de participantes desde agosto hasta diciembre de 2017. Según del protocolo de los casos de estudios aseguraré una estructura lógica de este trabajo. Mediante el empleo del International Analysis and Development (IAD) Framework de Elinor Ostrom se mostrarán los diversos factores que influyen en el aprendizaje o no-aprendizaje colectivo de la agroforestería el valle central de Bolivia. El objeto de esta investigación es el de ahondar en el conocimiento de la agroforestería en Cochabamba y entender la adaptación a ésta a través del aprendizaje.

**Palabras claves:** agroforestería, Bolivia, acción colectiva, análisis institucional, aprendizaje.

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# 1. INTRODUCTION

As the world population increases, the need of more land cultivation accumulates. The popular cultivation-form of monocultures and fast growing crops increases the yield in short-term, but does not solve environmental problems and social needs in long-term (Magarey 1999, 11). According to the FAO “Food security exists when all people, at all time, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO 1996, s.p.).

In terms of cultivation systems there are already known practices that could lead to a more sustainable usage of soil and more secure productions (Macklin 1990, 2 seq.). For example, a cultivation form in which trees and shrubs interact, ecologically and economically, in a significant manner with crops and/ or animals (Lundgren 1982, 7 seq.). This form of cultivation is called agroforestry. But still, it is mostly unknown in the central valley of Bolivia and small-scale farmers fear of adapting new technologies that could lead to an insecure production outcome (Cozón s.a., 1). Thus, reality shows us the difficulties to make a change.

Cochabamba, a city in the center of Bolivia, known for the fertile soils and agriculture traditions already showed during 2000 to 2005 that it is possible to make a bottom-up change that comes from people itself (cf. Schorr 2005, 126). It does show how effective a social cohesion can make a change. Therefore, this thesis aims to answer the following question: How are small-scale farmers learning collectively agroforestry in the central valley of Bolivia? This thesis aims to show how farmers collectively or not implement agroforestry practices through a development project in two different regions. Further, the thesis will use the Institutional Analysis and Development (IAD) Framework to understand the institutional dynamics in the implementation of an agroforestry project in Cochabamba, Bolivia (Ostrom 2005, 13 seq.).

Following to this introduction the methods used to answer the research question will be explained. The next chapter aims to illustrate the theoretical background of the cultivation form agroforestry and the used framework to analyze the cases. I will analyze and compare two cases, their success and failure during community organization. These cases will be described in the fourth part of this thesis by using the IAD Framework (Ostrom 2005, 13 seq.). Furthermore, the discussion and conclusions are drawn.

## 2. METHODS

Based on an empirical study I will answer the research question. Therefore, this thesis is a field research approach. Through participant observation (Iacono et al. 2009, 1 seq.) and qualitative interviews (Yin 2009, 106 seq.) from 31. of July until 17. of November 2017 in Cochabamba data were collected, as well as from the project proposal. The case study protocol served to guide the field work and Interview were transcribed. Table 1. Illustrates the combinations of the tools of data collection:

Tab. 1: Source of data

<b>Method</b>	<b>Farmers using Agroforestry (FA)</b>	<b>Agroforestry-engineer (EA)</b>	<b>Head of Agrecol Andes (HA)</b>	<b>Scientist investigating in Agroforestry (SA)</b>	<b>Cooperatives in Agroforestry (CA)</b>
Interview (I)	8 (I)	1 (I)	1 (I)	1 (I)	1 (I)
Direct- & Participant Observation (O)	Project involvement through temporal employment				
Documents (D)	Project Proposal (3); ECO-SAF papers; report on expenditure of funds				

The cases have been selected because they are located in Cochabamba, the central valley of Bolivia which is a new area applying agroforestry for most farmers. Moreover, both cases are similar but they have different external support, distinct stages of implementation of the agroforestry technique and various biophysical conditions. The variable “location” cannot be changed and influences the outcome of the cultivation. However, the variable of “external support” could be changed if there is a profitable outcome which leads to different techniques of implementation. An overview of the case studies is illustrated in table 2.:

Tab. 2: Short description of the case studies

<b>Case studies</b>	<b>Location</b>	<b>Biophysical conditions</b>	<b>External support</b>	<b>Accessibility</b>
Tiquipaya	Highland of Cochabamba, Bolivia	Terraced terrain	Yes	Though mountain route, difficult during rainy season
Arani	Valley of Cochabamba, Bolivia	Flat terrain	Partly	Though main route all the year

To analyze the research question, I will use the Institutional Analysis and Development Framework (IAD) by Elinor Ostrom (2005, 13 seq.). Further explanation about the IAD Framework will take place in the third part of this thesis.

Literature I have used to understand the concept of agroforestry, the IAD Framework and collective action in general in this paper comes from Springer, ScienceDirect, online university libraries and the library from the Agrecol Andes foundation in the city of Cochabamba. Using the snowball-system I looked up different author investigating in agroforestry in general and literature so far about agroforestry in Cochabamba, Bolivia.

### **3. THEORETICAL BACKGROUND**

#### Agroforestry

The term “agroforestry” is a combination of forestry and agriculture (Nair 1993, 14). Typical linkages to forestry are reforestation, plantation, natural forest management etc. and agriculture applies to e.g. annual crops, livestock, perennial forages etc. (Nair 1993, 15). Therefore, an agroforestry system includes many diverse and complex systems which makes an exact classification and definition difficult (Macklin 1990, 1). However, according to Lundgren (1982, 7 seq.) agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economical interactions between the different components (Lundgren 1982, 7 seq.).

Conforming to this definition an agroforestry system involves the following:

- “There are at least two or more species of plants, one that is at least a woody perennial;
- an agroforestry system has at least two or more outputs;
- the cycle of an agroforestry system is always more than one year;
- and even the simplest agroforestry system is more complex, ecologically, and economically, than a mono-cropping system” (Nair 1993, 14).

This thesis deals with such an agroforestry system as a tool for small-scale farmer to guarantee a sequent yield (with the focus on apple trees) as well as a sustainable usage of theirs soils and hydrologic balance.

## Collective Action

When a group of people organizes and monitors themselves to work toward a mutual goal these people engage in a collective action (Ostrom 2005, 13 seq.). People need to have the confidence to invest in collective activities, knowing that others will also do so (Pretty & Ward. 2001, 211).

To successfully accomplish a collective action project there are some key factors: relation of trust; transparency and communication flow; common rules, norms and sanctions; connectedness, network and groups (Pretty and Ward. 2001, 211). Further, Olson (1965, 1) claims that groups of individuals with common interests are expected to act on behalf of their common interests much as single individuals are often expected to act on behalf of their personal interests. He also writes about “rational, self-interested individuals” who will not act to achieve their common or group interests (Olson 1965, 2). A well-known example is “The tragedy of commons” presented by Garrett Hardin in 1968.

Forest can be managed as common goods (cf. Ostrom 1990, 30 seq.). Agroforestry is an option that farmers manage their forests. The term “common pool resource” (CPR) indicates the free availability because of its large amounts and nobody is excluded of making their own profit of it (Ostrom 1990, 30), e.g. fishing, oceans, and in this case soil and knowledge when applying agroforestry in the forest. As this thesis analyzes the learning of agroforestry, I adopted the basic components of the IAD Framework designed for the institutional analysis and the CPR management (Ostrom 2005, 13 seq.). The IAD Framework is built up of the following as you can see in figure 1:

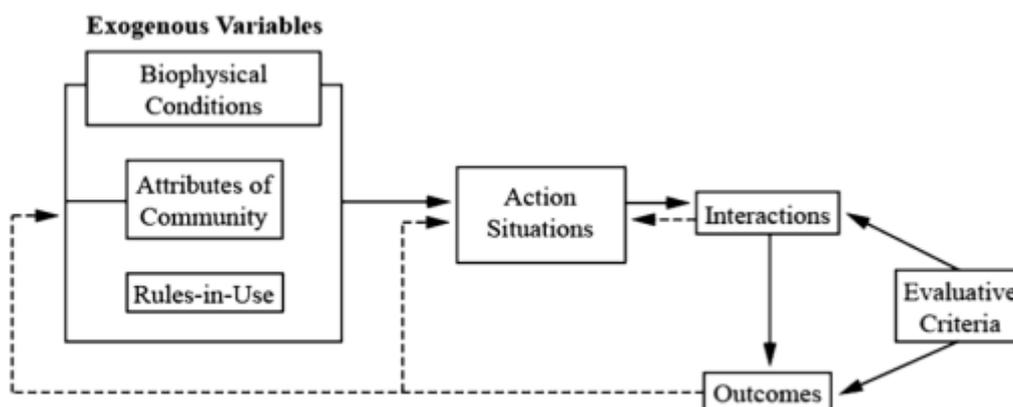


Fig. 1: Institutional Analysis and Development (IAD) Framework (adapted from Ostrom 2005, 15).

The first section of the IAD Framework describes the exogenous variables (social, cultural, institutional and physical environment) that affects the structure of the action arena (Ostrom 2005, 16). The heart of the framework is the action arena, where actors interact, select actions, engage in patterns of interactions and face different challenges (Ostrom 2005, 13). Thus, it produces outcomes that is shaped by both: the outputs of the action situation and the exogenous variables which in turn affects participants and the action situation (Ostrom 2005, 15). As following the participants evaluate their actions and outcomes, which affects again any stage of the process (McGinnis 2011, 172). Through feedback the whole process may affect further inputs and process within the action situation (McGinnis 2011, 172).

For this case study, I affiliate the following categories of analysis directly related to the IAD Framework (Quiñones-Ruiz et al. 2016, 105 seq.): 1) biophysical characteristics, to illustrate the territorial conditions of agroforestry in Cochabamba; 2) attribute of the community, to show the various characteristics of the involved actors; 3) rules in use, to identify rules of the game (formal and informal) that would shape the action arena; 4) action arena where actors interact, learn and make decisions and 5) the outcome, to see if there is a collectively learning or not of agroforestry.

## **4. RESULTS**

This sections presents the collective initiatives to engage in the learning of agroforestry of small-scale farmers in Cochabamba, Bolivia. The adaptation of this cultivation technique requires a learning willingness among the farmers and the acceptance of changing their trusted traditional cultivation form. Hence, this section presents and analyzes this learning and adaptation process. According to the IAD Framework the two cases will be illustrated (Ostrom 2005, 13 seq.).

### **4.1. Reasons to practice agroforestry**

There are different reasons why farmers willing to change their form of cultivation and engagement in a collective action or not to do so. Adopting the agroforestry technique could lead to a series of benefits, but sill farmers are worried of the accumulation of knowledge they need to know for a successful cultivation (I-EA, I-SA). Agroforestry techniques vary from every parcel (Macklin 1990, 2 seq.). There are different environmental factors and conditions

that make every farmer's agrarian land distinct to adopt the agroforestry technique (Cazón s.a., 2 seq.).

Apart from that fact, the city of Cochabamba is dense populated and few space for agricultural activities is available. As a result, productive land is shift towards the surrounding mountains, which involves the national reserve *Tunari* (*Parque Nacional Tunari*). Moreover, essential sources of fresh water and main reservation of trees can be found in the *Tunari* (D, O). According to local environmental engineers the adaptation of an agroforestry system in this park could be the closed natural systems for cultivation activities regarding to the natural forest system (I-EA, I-CA).

However, the uprising population of *Cochabambinos* and the need of nutrition makes the rightful conservation of the natural environment difficult. The trend of monocultures and fast growing crops still seems much more attractive to local small-scale farmers (O). By expanding this usage of mono-cultivation, the problem of water access and air pollution in the isolated valley of Cochabamba increases dramatically, which enables other environmental problematics in the future (I-SA).

Therefore, a rethinking of a suitable form of cultivation in the surroundings of the city of Cochabamba is fundamental. Agroforestry is a way of promoting the sustainable usage of soil and fits as a nature close systems to the local ecosystem (I-EA, I-CA). Furthermore, agroforestry promotes a diversity in nature and nutrition (I-EA, I-HA).

## 4.2. The case of Tquipaya

### 4.2.1. Biophysical characteristics

Tquipaya is a municipality in the center of Bolivia with boarder to the city of Cochabamba (Figure 2). Local people call this place one of the greenest department of Cochabamba which has its long agricultural tradition (I-EA, I-HA). Local small-scale farmers mainly cultivate potatoes, corn and wheat which reflects their daily nutrition composition (O): a lot of carbohydrates and very few vitamins and minerals.



Fig. 2: Implementing agroforestry with apple trees in Tquipaya

Agriculture activities are mainly based in the highlands in a northerly direction (up to 4000 above the sea level). There is only one road to the communities of Tquipya, which is more like a narrow gravel road, which makes accessibility difficult during rainy season (O).

The parcels vary from cultivation compositions, hillside location and attitude (O). All these factors have a potential input on the environmental conditions of this area and the sessional yield (I-SA). Furthermore, most agricultural activities are in national park area *Tunari* where most tree accumulations of Cochabamba can be found which includes the rare regional species of *qiwiña* (*Polylepis*) (D, O).

### 4.2.2. Attributes of the community

The agroforestry project in Tquipaya (*agroforestería dinamica*) involves several actors from different sectors: Agrecol Andes, a Non-Government-Organization (NGO) and the local small-scale farmers, including their families, are the main actors of learning agroforestry (I-HA, I-EA). The NGO Agrecol Andes is a local organization which promotes a sustainable development of regional farmers. They are linked to a scientific network in Germany, with the key person Noemi S. Kaulich who does research on agroforestry (*Mollesnejta*), and the agroforestry network *Espacio compartido en sistemas agroforestales* (ECO-SAF) to promote knowledge and experience in Cochabamba (D).

Farmers within the community are connected through the head of the community (*el dirigente*) (O). He is the key person in terms of communication among farmers and the realization of a

project within the community (I-EA). Further, he represents the main voice facing the local authority (*Alcaldía de Tiquipaya*) (O).

Moreover, a political influence of the agroforestry project has the local authority of Tiquipaya (I-HA, I-SA). As they see themselves as an ecological town they are promoting the agroforestry project and work in successful cooperation with Agrecol Andes and local farmers (I-HA, I-EA). Part of the local development of agroforestry they are already promoting financially by themselves, but still with training help of the Agrecol engineer (I-EA).

However, most parts of the cultivation areas are located in the national park *Tunari* (since 1962), which is under the authority of the *Tunari* park management linked to the higher department of national parks in Bolivia *Servicio Nacional de areas protegidas* (SERNAP) (D). Due to the protection as a national park the inhabitants and farmers have distinct obligations for the reservation and protection of the natural environment in this area (D).

The local authority of Tiquipaya, Agrecol Andes and local small-scale farmers can be seen as a horizontal integration (D, I-EA). On the other hand, external financial organizations and family supportive organization, especially Nature Fund and the *Centro estudio y trabajo de la mujer* (CETEM), and the park management SERNAP regarding to the other actors can be seen as a weak vertical integration (D, I-EA).

#### **4.2.3. Rules in use**

2014 Agrecol Andes started with financial help from Nature Fund the project *Agroforestería dinámica* with the first implementation of one agroforestry parcel in *Apote*, Tiquipaya. At the end of the year 2016 there were 18 new agroforestry parcels (D). During the implementation, a problem was the location of the national park *Tunari*, because of the legislation farmers are not allowed to cultivate in this area (I-HA). But through a creation of buffer zone in 2015 and the adaptation of agroforestry, farmers are allowed to cultivate in lower attitude park regions (D, I-SA).

Besides, the general rule if a farmer is willing to adopt the agroforestry technique is an obligatory condition that he is the rightful owner of the agrarian land and willing to use the agroforestry technique, which includes the synchronically cultivation of local woody plant (*e.g. Schinus molle*) for organic matter, diversity and hydrologic balance (I-SA, I-HA).

#### **4.2.4. Action arena**

The project idea of adopting agroforestry comes from an advanced model of the tropical department *Beni*, Bolivia (I-HA). The aim was and still is to support small-scale farmers to adapt their previous cultivation form into a sustainable cultivation method (I-HA). Therefore, on demand of the local farmers the environmental engineer Serafin Vidal of the foundation Agrecol Andes, with financial support and work capacity of the local municipality, explains and shows on a developed agroforestry parcel the potential outputs and its benefits (I-EA). If local farmers agree to cultivate using agroforestry which includes non-yield woody trees, parts of financial burdens will be supported by Agrecol Andes and the local authority (I-EA).

However, agroforestry is a complex system and farmers have to learn new requirements to keep it alive and productive. Therefore, monitoring and tree cutting training are offered by Agrecol Andes. First, the experimental parcel of Noemi S. Kaulich (*Mollesneja*) served as a demonstration plot of a successfully developed ecosystem (D). Since 2017, the third phase of the project, training activities are directly and individual on a farmer's parcel to adopt the specific needs (D). Mostly Serafin Vidal offers this training for two years (D).

#### **4.2.5. Outcome**

According to Serafin Vidal there are currently [November 2017] 23 farmers in Tiquipaya using agroforestry. The fact that local farmers are critical using woody trees on their agrarian land, because of the [mistaken] belief that woody trees absorbing soil resources and water which should be determined only for crop-productive trees (I-EA). Doubt and the accumulation of knowledge among small-scale farmers reduces the attractiveness of using agroforestry (I-EA). Nevertheless, by showing the potential outcomes and nutrition securing, which impulses especially the women of a farmer's family they overcome the obstacle of doubt (I-EA, I- HA).

Further, the local authority of the municipality adopted the concept and realizes their own projects (I-HA). First collective efforts are in process on the part of local authorities, but still with advice from Serafin Vidal (I-HA).

However, there are little collective efforts regarding the implementation of agroforestry on part of small-scale farmers (I-EA). A key person in realizing collective efforts among local farmers is the head of the community (O). His position within the community allows him to engage inhabitants in collective project regarding agroforestry, for example construction work (e.g. an

essential water cistern for the agrarian plot) that needs work capacity (O). But still, an adaptation and the resulting learning occurs mostly on an individual level (I-EA).

### 4.3. The case of Arani

#### 4.3.1. Biophysical characteristics



Fig. 3: Training of apple tree cuts in Arani

Arani is located in the flat valley of Cochabamba (Figure 3). The main road to the municipality is in good condition and accessible during the whole year (O). The municipality is characterized by eolian denudation and frost in the morning due to flat terrain and surrounding high attitude mountains shaped by nicks, which is in favor of strong volumes of wind during rainy seasons. (O, I-SA).

Besides, the municipality is famous for their bread (*Pan de Arani*) and was a main provider of wheat for central Bolivia (I-SA). As a result of monocultures and permanent usage of agrochemicals soil fertility and its productiveness decreased significant (I-SA).

#### 4.3.2. Attributes of the community

The University of San Simon in Cochabamba with their forestry institute located in Arani (ESFOR) plays an important role in learning agroforestry besides Agrecol Andes and other organizations (I-SA). The institute has its own experimental parcels for practice and investigation in agroforestry (D). Agrecol Andes has a good established network with the University and their agroforestry students. Moreover, Serafin Vidal teaches every Wednesday a more practical approach to agroforestry with the students. Likewise, local students often have their own parcels or they are involved in an agricultural family business, which increases the output of learning agroforestry among small-scale farmers (I-EA, D).

However, local small-scale farmers are connected through the head of the community, like most communities in the central valley of Bolivia (O). He is the main representative among farmers (O).

Besides, agroforestry in Arani involves also the local authority (*Alcaldía de Arani*) and other social organizations like CETEM, *Bosque y Comunidades* (ByC) and ECO-SAF (D). As well as the organization Nature Fund for financial issues (D). However, the University of San Simon, Agrecol Andes and local small-scale farmers can be seen as a horizontal integration (D, I-EA). According to the farmers and involved social organization they can be seen as a weak vertical integration (D, I-EA).

#### **4.3.3. Rules in use**

In relation to the dynamic agroforestry project the first parcel in Arani was implemented in 2015 (D). However, the fact that Arani is in the same project as Tiquipaya brings a similar form of implementation patterns with different actors like the University of San Simon (I-EA). The University establish a larger community (from students to traditional farmers) interested in agroforestry (I-EA). Furthermore, financial income for the municipality due to the students (I-SA). However, in terms of the realization of a new agroforestry parcel and the learning coming along with it depends on the legal property of agrarian land and the will of local farmers (I-EA).

#### **4.3.4. Action arena**

Due to the network of the engineer Serafin Vidal to the local authority of Arani and University of San Simon, he provides a major input to the implementation and learning of agroforestry (O, I-HA,). Additionally, local small-scale farmers are more in touch with agroforestry because of the forestry institute (O, I-EA).

However, the realization of a new agroforestry parcel depends (currently) on the request of a local small-scale farmer to Serafin Vidal (I-EA). The request is mostly informal or via the head of the community (I-EA). Moreover, monitoring and training courses (e.g. correct tree cutting, specific adaptation to the farmer's parcel) are offered during the next two years directly on a farmer's parcel (D). In terms of the local authority, there is only little involvement in the realization of a new agroforestry parcel (I-EA).

#### **4.3.5. Outcome**

Currently [October 2017] there are 24 agroforestry parcels of local farmers in Arani and due to the fact of environmental (e.g. frost, wind) resilience and re-fertilization of soil the interest of local farmers are increasing (I-EA, D). The fact that the institute of forestry is located in Arani increases the learning output and participation even more (D, I-EA).

However, collective efforts among local farmers are little to nothing regarding agroforestry (I-SA, I-HA). Still the critical standpoint of farmers against non-yield woody trees, a lack financial resources among farmers and accumulation of knowledge decreases the attractiveness of agroforestry (I-SA, I-HA).

#### **4.4. Comparison of the cases**

##### Learning Agroforestry

Both cases are similar in terms of learning agroforestry due the fact that both municipalities are involved in the same project (D). However, according to the IAD Framework the exogenous variables shape the action arena where interactions and learning takes place (Ostrom 2015, 13). Due to the different kind of location and their accessibility, high valley in Tiquipaya and low valley in Arani, the involvement of actors varies. In Tiquipaya, the involvement of the park management of *Tunari* (SERNAP) besides Agrecol Andes and local farmers requires a more carefully driven concept of agroforestry and hence the learning of it (D). The local authority of Tiquipaya and the heads of the communities within the municipality are both in favor of agroforestry, as well as the SERNAP authority and therefore a supportive infrastructure for the adoption of agroforestry and its learning is given (I-EA). Thus, a variety of actors from different sectors influences a supportive learning of agroforestry among local small-scale farmers.

The institute of forestry studies of the University of San Simon in Arani has as well similar goals among learning agroforestry, but still a more theoretical access with the focus group of students (D). Further, the local authority in Arani benefits of the students, but relating to the authority in Tiquipaya the municipality is not agreeable and supportive to the concept of agroforestry (I-EA, I-SA).

##### Collective action

In terms of collective action there are very little efforts among small-scale farmers. In both cases the environmental engineer of Agrecol Andes is the key person as well as the heads of the communities among local small scale-farmers for adopting and learning agroforestry. Local farmers have a lot of trust and confidence in Serafin Vidal (O). Due his connections to farmers and heads of the communities he has a central and crucial position in starting and engaging in collective efforts regarding agroforestry (I-HA).

In Tiquipaya a central objective among agroforestry and its adaptation is the security of water distribution close to the farmer's parcel (D). The installation of a water cistern acquires labor capacity and specialist knowledge. So, a voluntary effort among farmers is required due the fact of little money within a project and difficult accessibility for the shipment of construction equipment (I-EA, O). Hence, the connection network of the head of the community and his position within the community in Tiquipaya achieves a collective appearance of (mostly local) workers for the farmer in need (O). In return the farmer who requires support in form of collective action provides hospitality (this work requires couple of days) and alimentation during work (O). Basic collective efforts regarding agroforestry among farmers can be seen through the connection network of the head of the community (O).

The case of Arani does show little effort of collective actions regarding agroforestry among local small-scale farmers (I-EA, I-HA). Once a week farmers meet and discuss about ongoing issues regarding agriculture and agrarian plots (I-CA). Therefore, first fundamentals of collective actions are built, but regarding the collective learning of agroforestry there are still no achievements (I-EA).

## **5. Discussion**

### **5.1. Discussion of the IAD Framework regarding the cases**

The selected variables of the IAD Framework were very favorable for understanding the distinct influences that shape the action arena and the final results of learning agroforestry among small-scale farmers (Ostrom 2005, 15). I could assign most relevant factors and variables to categories and locate it within a structure of logical relationships. Hence, a logical overview of the main influences of the cases could be drawn in a coherent order.

Despite, the procedure of adopting agroforestry and its learning are fulfilled in an informal way and mostly only oral agreements are made for succeeding approaches. Further, agreements with small-scale farmers are discussed in *Quechua* which made the understanding difficult to capture the relevant information. Moreover, agricultural policy meetings in Tiquipaya and Arani, which includes the local authority, are internal holdings and the accessibility for (external) researchers is challenging.

However, the broader scope of the IAD Framework and its specific adaptation to these cases made it possible to encapsulate the relevant information in terms of collective efforts and learning agroforestry. Furthermore, multiple methods as well as the triangulation have hopefully supported the validity of the cases (Yin 1994, 98 seq.).

## **5.2. Discussion of results**

The implementation of agroforestry parcels and its learning in Tiquipaya show first outputs including first collective engagements on the part of the local authority. Due to the fact of ecological oriented municipality (“*ciudad de las flores*”) and its agricultural traditions, small-scale farmers are more sensitized to environmental issues and its uprising problematics (above all *el niño* & deforestation). With it comes a greater will of engaging in environmental and agricultural transition. Further, an adaptation of the agriculture technique agroforestry which leads to a more nature close system (Carruthers 1990, 150). Likewise, local key persons (heads of the community) understand the need of adapting a form of cultivation that lead to permanent soil fertility and hydrologic balance in long term (Cozón s.a., 2). A supportive structure and collective engagement of adopting a green growth economic of agriculture is essential for future oriented conservation and sustainability (cf. Kruijssen et al. 2009, 51).

In contrast, the municipality of Arani is monoculture- and fast growing crops oriented, including agrochemicals and pesticides. Further, this case illustrates that missing public support lead to be of little to no interest among small-scale farmers, including to engage collectively and individually in learning agroforestry. According to Kruijssen et al. (2009, 51) a larger involvement of producers and consumers in the social leaning process [with the head of the community as key person] is important for more environmental sustainability.

However, the accumulation of knowledge of the complex system of agroforestry supports an unattractiveness and lack of motivation among farmers. Agroforestry is a system that depends strongly on a carefully driven management for success (Carruthers 1990, 149). Corresponding to Kruijssen et al. (2009, 51) an improvement of exchange local knowledge and engage in more collective learnings improves diversity and with it the environmental condition. Hence, the adaptation of a sustainable cultivation technique. However, the location of the forestry institute in Arani favors a general knowledge of the existence of agroforestry. A more connected infrastructure between the authorities and farmers could led to a greater adaptation and learning (Devaux et al. 2009, 37). Further, Devaux et al. claims that a diversity of all participants within

a community are potentially more productive in terms of social learning and innovative behavior.

Both cases show the importance of exogenous variables that shape the action situation and therefore the adaptation of agroforestry (Ostrom 2005, 15). With it comes the learning of this cultivation form. Thus, if involved actors and environmental conditions are not in favor of agroforestry and in general lack of knowledge about agroforestry, a successful learning is embossed by doubt among farmers and obstacles with local authorities. Moreover, no collective engagement can be registered.

## **6. Conclusion**

Both cases indicate little collective learning of agroforestry among small-scale farmers. The adaptation of agroforestry of both cases are shaped by context-specific environmental conditions, the degree of involvement of different actors and internal rules among farmers. Moreover, the willingness to adopt this cultivation form on part of the small-scale farmer and the acceptance of learning new requirements are the main obstacles of the transition from traditional agriculture to agroforestry.

The case of Tiquipaya illustrates the benefit of the involvement of the local authority. A good connected infrastructure between farmers and municipality authorities can be seen. Therefore, successful collective engagements between small-scale farmers, with the head of the community as representative, and local authority are registered.

The institute of forestry in Arani and the established network to the environmental engineer of Agrecol Andes contribute to a greater learning output of agroforestry. The broader involvement of different generations (students to traditional farmers) lead to a more common knowledge of agroforestry and its benefits. Hence a more connected network between the forestry institute and local farmers would be in favor of a greater learning output and collective engagements.

In conclusion, taking the IAD Framework by Ostrom (2005, 13 seq.) into regard leads to a profound understanding of the complexity of adapting and learning agroforestry. The specific adaptation of the framework supported to illustrate the different variables that shape the final output of learning agroforestry.

## List of abbreviations

ByC...Bosques y Comunidades  
CETEM...Centro estudio y trabajo de la mujer  
CPR...Common pool resource  
ECO-SAF...Espacio compartido en sistemas agroforestales  
ESFOR...Escuela de ciencias forestales  
IAD...International analysis and Development [Framework]  
NGO...Non-Government Organization  
SERNAP...Servicio Nacional de areas protegidas

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