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School of Management, Economics, Law, Social Sciences and International Affairs

MASTER THESIS

Water, Livelihood and Prosperity

Socio-Economic Impact of Water Harvesting in Brazil

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Abstract

Rural poor in the Alto Jequitinhonha are heavily affected by water scarecity and environmental degradation. In order to reduce the challenges the farmers face in one of the poorest regions in Brazil, the Swiss Foundation Vivamos Mejor invests since 2008 in rainwater harvesting technologies. The goal of the investments is to offer new opportunities to the farmers and to improve their resilience. The local NGO Centro de Agricultura Alternativa Vicente Nica already attended 151 families directly with the construction of ponds, basins and diques as well as their communitarian work, sponsored by Vivamos Mejor. However, the socio-economic impact of the NGO's activity and more specifically of the water harvesting technologies needs to be explored further. The current study tries to close the gap and analyses the changes in the livelihood strategy provoked by the constructions by means of the Sustainable Livelihoods Framework. Furthermore, an economic payback calculation is conducted in order to evaluate the cost-effectiveness of the installations. The rainwater harvesting technology has a positive impact on the agricultural production and the development of the local economy, once the farmer is adapted to the new reality.

Key words: Alto Jequitinhonha, Vivamos Mejor, Centro de Agricultura Alternativa Vicente Nica, Sustainable Livelihoods Framework, rainwater harvesting technologies, socio-economic impact, payback.

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Abbreviations

- CAV = Centro de Agricultura Vicente Nica
- CHF = Swiss Franc
- DFID = British Department for International Development
- Etc. = et cetera
- EFAV = Escola Família Agrícola Veredinha
- EMBRAPA = Empresa Brasileira de Pesquisa Agropecuária
- FAO = Food and Agriculture Organization of the United Nations
- NGO = Non-governmental organization
- Núcleo PPJ = Research Centre Apoio à Agricultura Familiar
- Obs. = Observation
- OC = Opportunity Cost
- PRONAF = Programa Nacional de Fortalecimento da Agricultura Familiar
- P1MC = Programa 1 Milhão de Cisternas
- RWH = Rainwater Harvesting
- R\$ = Brazilian Real
- SLF = Sustainable Livelihoods Framework
- S1 = Season one after construction
- S2 = Season two after construction
- S3 = Season three after construction
- UFLA = Universidade de Lavras
- UN = United Nations
- VM = Vivamos Mejor Suiza
- Y0 = Year of construction
- Y1 = One year after construction
- Y2 = Two years after construction
- Y3 = Three years after construction
- Y4 = Four years after construction
- Y5 = Five years after construction

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1. Introduction

1.1. Introdution to the Topic

The region of Turmalina in the Alto Jequitinhonha is colloquially known as the valley of *misery*. National and regional authorities are struggeling to provide the population with the necessary instruments in order to foster the rural development. Water scarcity can be considered one of the main factors for the persistent problems. The establishment of large eucalyptus plantations in the 1960s and 1970s has had a crucial influence on the water cycle and contributed to a degradation of the environment (Pereira Lima, 2013, p. 98). As the wellbeing of the region and food consumption depend to a large extent on the local agricultural production, Turmalina and other municipalities rely on the (constant) availability of water. By the end of the 20th century, the NGO Centro de Agricultura Alternativa Vicente Nica (CAV) identified the need for assistance of the rural poor. The association managed to implement a series of rainwater harvesting (RWH) technologies, aiming at assuring the water availability for agricultural production and household consumption throughout the year. Additionally, the measures contribute to a revitalization of the whole region (Ribeiro et al., 2013, p.43). International organizations fostered the development with their financial support. Vivamos Mejor (VM), a Swiss foundation, supports specific projects related to the problems of water and education. The investments of VM in the development of the Alto Jequitinhonha started in 2008. Since then, the foundation has contributed with a considerable financial amount to the construction of water harvesting ponds, basins and diques with the objective to stimulate the sustainable development of the rural area. This study analyses how the construction of the RWH technologies and CAV's work in the communities facilitates the access to assets to the beneficiaries and how it shapes the livelihood of the farmers. Additionally, it also aims at calculating the payback period of the investments made by VM. Based on these objectives of the study, the following research questions arise:

- How did the construction of RWH technologies and CAV's engagement in the communities shape the livelihood of the farmers according to the Sustainable Livelihood Framework (SLF)?
- What is the payback period of the investments for the beneficiaries, considering the increase of additional net revenue generated through agriculture?

In order respond the research questions, the first part of the study introduces to the Sustainable Livelihoods Framework (SLF), a widely used theoretical model analysing poverty reduction in agricultural research. Additionally, the essential concepts of Family Farming, Food Security and Resilience, notions frequently referred to in the Brazilian context and this study, are defined. The research methodology also forms part of the introductive remarks. In a second part, the historical context of the Alto Jequitinhonha and the transforming elements are explained according to the SLF. The introduction to CAV's activities shows how the organization tackles the challenging environment in the valley. The third section describes the peculiarities of the projects visited and summarizes VM's investments in the region. Under part four the impact evaluation is made according to the results of the conducted interviews. The fifth section, the discussion, summarizes the findings of the changes in the livelihood strategies of the beneficiaries and includes the economic payback calculation.

1.2. Theoretical Approach on Sustainable Development

The goal of VM's investments in Latin America is to enable and promote sustainable development in order to support disadvantaged people in the region to improve their overall situation (Vivamos Mejor, 2014). Even though there exists an extensive literature on the concept of "sustainable development", there is no such thing as a single unified philosophy of sustainable development (Hopwood et al. 2005, p.28). There are often uneasy compromises between different objectives embedded in the same definition (Scoones, 1998, p.5). As a consequence, it is apparently difficult to define a framework or theory fitting appropriately to the socio-economic impact assessment. The opinions diverge fundamentally with regard to what to focus on when analysing the impact. Hopwood et al. (2005, p.6), for instance, point out that the theoretical debate on sustainability is often controversial between authors favouring the environmental approach and others considering the socio-economic factors as the most important determinants for an analysis on sustainable development. According to the same authors there will always be a tradeoff between environment and humanity (Hopwood et al. 2005, p.29). The objective of this study is not to take sides with one or the other theoretical tendency but to stress the relevance of a differentiated consideration.

With an evaluation of the socio-economic development of smallholders in the rural area of Minas Gerais, enabled amongst others through the RWH technologies implemented by CAV,

this study aims at providing a holistic feedback. The assumption is made, that the water availability has a positive impact on the agricultural production and its output. Hence, an intact environment is fundamental in order to stimulate agricultural production and therewith enable the socio-economic development in rural areas. Thus, the importance of the environmental factors can surely not be neglected in our analysis. In this line, Galizoni et al. (2013, p.152) state that water scarcity has to be understood through a cultural, environmental and economic analysis and therefore the SLF is a pertinent concept.

1.2.1. The Sustainable Livelihoods Framework

The SLF is a versatile tool to analyze poverty reduction (DFID, 1999, p.2). The concept of sustainable livelihoods is composed of many ideas and interests, coming together from different strands of the debate around sustainable development (Scoones, 1998, p.7; Walker et al., 2008, p.20). The framework is particularly appropriate to analyse the conditions of rural poor, but does not focus exclusively on it. In general, poverty in agricultural research cannot be reduced entirely to questions of economics and productivity but it also has to include elements of the farmer's environment (Carpenter & McGillivray, 2012, p.13). By considering these additional influences on a family's life, the model manages to reflect reality (Adato & Meinzen-Dick, 2002, p.20). The framework allows us to order the complexity of sustainable development and makes clear a series of relevant factors that affect livelihoods (DFID, 1999, p.2). However, we have to be clear that this does not eliminate all tradeoffs, as previously mentioned.

In order to understand the whole process of how the SLF is assessed, Adato & Meinzen-Dick (2002, p.4) illustrated the different elements of the analysis (see Figure 1). The framework takes into account the influence technology can have on a farmer's livelihood, leading to changes in the different elements of the framework elucidated below. Furthermore, as the model suggests, the activity and operational methodology of the NGO itself can shape the beneficiaries' livelihoods.



Figure 1: Sustainable Livelihoods Framework and Impact of Agricultural Technology Source: Adato & Meinzen-Dick, 2002, p.7

1.2.1.1. The Vulnerability of Family Farmers

The livelihood framework has its roots in the analysis of the well-being in an environment. Thereby the main preoccupation of the model is the vulnerability of the individual, group or even region. Thus, the starting point of an analysis is the so-called Vulnerability Context (DFID, 1999, p.3). The vulnerability derives mainly from the fact that poor people's livelihoods and inherent fragility cannot cope with stress. This means that people's livelihoods and wider availability of assets are fundamentally affected by critical trends as well as by shocks and seasonality (Carpenter & McGillivray, 2012, p.19). In other words, to take the farmer out of the situation of inherent fragility and poverty, the goal is to reduce or, in the best case eliminate the danger of external influences. The framework assumes, that the individual has little influence on these three types of external factors often deteriorating their status and limiting their options. Normally a reduction of vulnerability or an improvement of the farmer's resilience can be achieved by supporting poor people to develop their access to assets, elaborated in the following subchapter (DFID, 1999, p.4; Scoones, 1998, p.8).

1.2.1.2. Access to Five Assets

The SLF is composed of five different categories of assets.

• *Human capital* represents skills, knowledge, ability to labour and good health that enable the individual to pursue different strategies to achieve livelihood objectives. It

can be achieved by attending trainings or school, by having access to medical treatment, etc. (DFID, 1999, p.7).

- Social capital stands for the social resources surrounding the poor (Scoones, 1998, p.8). Networks and connectedness, as well as memberships or relationships of trust provide a more promising environment to enable the sustainable livelihood (DFID, 1999, p.9). This interaction with society can help to improve economic efficiency or facilitate innovation.
- Natural capital refers to the totality of natural resources and ecological processes and services from which all human livelihoods derive (Carpenter & McGillivray, 2012, p.22). In agriculture, the relationship with the Vulnerability Context is particularly close as many of the negative shocks are themselves natural processes. Thus, it exerts a direct influence on resource-based activities as agriculture (DFID, 1999, p.11). Water, a central element of this study, is part of the natural resources.
- *Physical capital* comprises the basic infrastructure and factors of production needed to support livelihoods (DFID, 1999, p.13). Productive activities can be considerably restricted when access to physical capital such as basic infrastructure, transportation, water or energy is not granted. The case of water shows us, that physical capital is very closely related to other assets. One of the main challenges is that this sort of capital can be very expensive to acquire (Carpenter & McGillivray, 2012, p.22). As a consequence, the DFID (1999, p.14) stresses the importance of participatory approaches when enabling the access to the physical asset to poor people in order to develop an ownership component.
- *Financial (or economic) capital* refers to both the stock and flow of financial resources (Carpenter & McGillivray, 2012, p.22). It is probably the most versatile of the five categories, due to its convertibility into other capitals or it can be even a direct achievement of a livelihood strategy, as shown later in this study (DFID, 1999, p.15).

1.2.1.3. Transforming Structures and Processes

Livelihood is also shaped and constrained by transforming structures and processes. This refers mainly to institutions, organizations, policies and laws that interfere significantly in the possession or access to livelihood assets. The transforming structures and processes are very complex elements of the SLF because they interact constantly with other elements of the concept. In general, the "structures" refer to those public and private-sector bodies that create

laws, implement policies, purchase goods, trade and provide a multitude of services to people (Carpenter & McGillivray, 2012, p.23). The "processes" in turn is a tool to explain the interaction between the structures and the individuals. Due to the wide range and complexity of structures and processes it is important to focus on the most significant ones (Carpenter & McGillivray, 2012, p.23). In other words, the structures build the hardware of the framework whereas the processes can be thought of as a software (DFID, 1999, p.21). The structures predefine the processes, the latter in the end provide incentives and grant or deny access to assets (DFID, 1999, p.21).

1.2.1.4. The Definition of Livelihood Strategies

The livelihood strategy stands for the range and combination of activities and choices that people undertake in order to achieve their livelihood goals (DFID, 1999, p.23; Scoones, 1998 p.9). They can be very diverse within a region or even a community. It is a dynamic process in which the farmer combines activities to meet their various needs at different times (DFID, 1999, p.23). The expansion of choice and value is important because it provides people with opportunities for self-determination and the flexibility to adapt over time (DFID, 1999, p.23). However, the livelihood approach does not aim at classifying the different choices of people. It seeks to understand the factors that lie behind the choice of strategy (Carpenter & McGillivray, 2012, p.23). Over the past decades, new opportunities emerged for the rural poor, associated with important cultural and social change and increased mobility. An important impact of this alteration for the households is the increased income through non-farm economic opportunities (Carpenter & McGillivray, 2012, p.23).

1.2.1.5. Livelihood Outcomes

Livelihood outcomes are the outputs of the livelihood strategies. In order to create a framework considering the broad strategies, the DFID (1999, p.25) defines a few relevant categories, namely:

- 1. *Increase of income* Income as a measurement for poverty reduction is criticized but should nevertheless not be neglected when it comes to an analysis of the outcome.
- Increased well-being and capabilities The notions provide a wider definitional scope for the livelihood concept, encompassing far more than the material concerns of food intake or income (Scoones, 1998, p.6).
- 3. *Reduced vulnerability* Through a better access to assets the farmers become less vulnerable to shocks, trends and seasonalities.

- 4. *Improved food security* Refers to the concept mentioned in the following section and it means having sufficient production and income to assure food consumption.
- 5. *More sustainable use of natural resource base* Refers to the ability of a system to maintain productivity when subject to disturbing forces (Scoones, 1998, p.6-7).

The list of relevant outputs for smallholders could be enlarged by other outcomes. So does Scoones (1998, p.7), who mentions the creation of working days as an important indicator of the livelihood outcome. Furthermore, the reduction in multidimensional poverty should also be considered according to some authors (Carpenter & McGillivray, 2012, p.24; Scoones, 1998, p.7). Multidimensional poverty is a concept including more factors than just income, expenditure per capita, etc. Many authors stress that variables like housing, literacy or provision of public goods should be included as part of the livelihood outcome (Bourguignon & Chakravarty, 2003, p.26; Alkire & Forster, 2011, p.84).

1.2.1.6. The Procedure in Agricultural Research

As the elaborated section on the SLF and as Figure 1 suggest, the whole analysis follows a step-by-step procedure in order to project a pertinent picture from the initial situation up to the outcome evaluation. As a first step, the context has to be analysed. Through this we can assess the biggest threats making the families more vulnerable, linked to the evaluation of the individuals' or groups' asset possession in order to determine the access to livelihood resources. As it varies considerably among communities, we will discuss this section when explaining the context of the Alto Jequitinhonha. By considering the relevant transforming structures and processes, we are adding another indispensable element to the whole contextualization. Apart from the analysed organization CAV, especially governmental institutions, partners and other NGOs in the region have to be considered. According to these drivers or constraints to the farmer's situation, the individuals opt for a certain livelihood strategy in order to achieve a maximum of livelihood outcome. These two elements will build the core of our analysis if the investments in the RWH technologies had a positive impact on the people's livelihoods. The framework tends to be more complex than other modes of analysis but its extensive reach gives us a pertinent feedback on the interventions executed with VM's investments.

1.3. Relevant Concepts

Under this section some relevant concepts for the study are elaborated more in detail. The notions are relevant for the theoretical framework; they possess an importance in agricultural research and in the Brazilian context.

1.3.1. Family Farming

In Brazil, since the late 1980s, family farming has enjoyed increasing popularity not only on the political agenda and amongst consumers, but also in academic research (Medaets, J.P. et al., 2003, p.5, Olalde & Portugal, 2004, p.1). Furthermore, family farming deserves a special attention due to its importance for human health and its contribution to agricultural production and thus to our alimentation (Fickert, 2004, p.25). According to FAO (2014), family farming is a means of organizing agricultural, forestry, fisheries, pastoral and aquaculture production which is managed and operated by a family and predominantly reliant on family labour, including both women and men. The concept includes all family-based agricultural activities on a small-scale, linked to several areas of rural development. This highlights the socio-economic, environmental and cultural importance of the smallholders in our society. The common definition of a small-scale farmer consists of three elements. It has to be 1) a small property, 2) family-operated and 3) with no or a very limited amount of non-family workers hired (Berdegué & Fuentealba, 2011, p.6). In order to strengthen the families involved in small-scale production, 2014 was declared the international year of family farming by the Food and Agriculture Organization of the UN (FAO, 2014).

Until the 1990s the term was not widely spread in the biggest South American country (Olalde & Portugal, 2004, p.3). The growing tension between the modernizing Brazilian agriculture focussing on commodity production and the smallholders in the rural areas had a significant impact on the initiation of this manifestation as the created wealth did not reach the rural poor (Galizoli & Basco, 2010, p.45). Since then, several NGOs and labour organizations of rural workers fought for the rights of families in the rural area and made the term become widely accepted (Fickert, 2004, p.24). As a consequence of this pressure through civil society and small-scale farmers, family farming became an important topic on the government's agenda. CAV forms part of the group lobbying for the smallholders' recognition and well-being.

According to statistics of the UN, family farming in Brazil employs 77% of the people engaged in agriculture (CEPAL, FAO & IICA, 2014, p.51). However, in Brazil there exists a

constant conflict between agribusiness and the concept of family farming. The smallholders with properties up to four modules of 40 hectares (FAEMG, 2014) are less competitive and by trend marginalized. The agribusiness, in turn, is entering territories where traditionally the small-scale farmers were cultivating. As a consequence, the conflict includes land and resource disputes as well as a competition for consumers.

1.3.2. Food Security and Resilience

During the World Food Summit in 1996, Food Security was defined as a situation in which "*people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life*" (World Food Summit, 1996). In other words, the person has at the same time physical and economic access to food (WHO, 2014). However, according to the Millenium Development Goals, the concept of food security goes beyond. Food availability and economic access are crucial components of the definition, but a more holistic characterization would include the factors of expanding, enhancing and sustaining people's ability to acquire and utilize the amount and variety of food they need to be active and healthy (FAO, 2014). Food insecurity afflicts communities throughout the world wherever poverty prevents assured access to food supply (Beddington et al., 2011, p.3). Thus, lack of food security makes the affected population more vulnerable. Besides the suffering it causes amongst the poor, it generally contributes to the degradation of natural resources, to a rural exodus and can provoke political as well as economic instability (Beddington et al., 2011, p.3).

Food security is important for this study because the concept is directly interlinked with the availability of water (Ribeiro et al., 2014, p.372; FAO, 2013, p.9). Water scarcity can negatively influence the agricultural production and thus limit the food production (Hanjra & Qureshi, 2010, p.365). In other words, new investments in improved water management can minimize the negative impact of water scarcity on livelihoods and partially increase the offer of water for food production in the Alto Jequitinhonha.

Through the construction of a RWH technology, the farmers should become more resilient to negative trends, shocks or seasonality (Food Security Information Network, 2014; Scoones, 1999, p.6). Many projects aim at guaranteeing food security in the short-term and resilience in the long-term (Canadian Hunger Foundation, 2012, p.9; Pain & Levine, 2012, p.6). Resilience is defined the ability to anticipate, absorb, accommodate or recover from the effects of hazardous events (Gitz & Meybeck, 2012, p.20). The term resilience is very much associated with vulnerability, risk and adaptive capacity (Pain & Levine, 2012, p.3). Building

the resilience generally starts with reducing the vulnerability (Gitz & Meybeck, 2012, p.19). According to FAO (2013, p.20), assisting smallholders is the most direct way to improve resilience and fight hunger. In this sense, the households aim at a livelihood, which has a high resilience against the shocks and stresses (Rakodi, 1999, p.318).

An example of severe crisis are the food crises of 2007 and 2008, which resulted in 50%-200% increase in food prices, driving 110 million people into poverty and adding 44 million more malnourished people in the world (Muza, 2012, p.1373). For the rural population of the Alto Jequitinhonha with a relatively high sensitivity to such disruptions, it is extremely difficult to deal with an abrupt rise in prices. As a consequence, food security and resilience is endangered. This can be overcome with an increase in local production and an empowering of the smallholders.

1.4. Methodology

Assessing the impact of investments in the agriculture sector is a very controversial topic. The SLF demands a qualitative household survey in order to provide a pertinent overview (DFID, 1999, p.20). An econometric analysis will not be conducted, due to the way in which so many factors are interrelated. This creates endogeneity problems that would require even larger data sets to be resolved (Adato & Meinzen-Dick, 2002, p.32).

1.4.1. Indicators for Impact Assessment

Some challenges appear when examining the impact of investments in agricultural projects. The first problem is that, in many cases, the project mainly aims at improving the agricultural production or the increase of returns to agriculture (Winters et al., 2010, p.6). Very often, when conducting an impact evaluation, an emphasis is put on the production variables. Such an analysis, focussing on production input and output measurement, is not always very meaningful because it tends to neglect other factors relevant for an improvement of livelihood (Winters et al., 2010, p.7). In order to develop a consistent range of indicators in line with the SLF, the indicators were divided into four different categories. First, the impact on production is analysed through a common set of indicators. The list includes 23 indicators (see appendix 1) and is based upon an extensive literature review on impact measurement in agricultural research (Alene et al., 2007, p.19; Fanta, 1999, p. 3; La Rovere & Dixon, 2007, p. 36-37; Winters et al., 2010, p.12; SAFA, 2012, p.63). Furthermore, the feedback of both, the donor and the beneficiary institution, contributed to the validation of the evaluation method and the identification of the relevant indicators.

1.4.2. Data Collection

Household Livelihood Surveys:

For the assessment of the different steps of the SLF, the author recurred to different types of data collection. As the study of Carpenter & McGillivray (2012, p.33) suggests in its methodological advice for impact assessment in agricultural research, 30 household livelihood surveys were conducted for the qualitative part of the evaluation. Each household survey lasted between 45 and 120 minutes and had the goal of analyzing the situation before the installation of the RWH technology through CAV, as well as discovering the significant changes for the families once they benefited from the implementation of the technology. The questionnaire used during the interviews can be found in Appendix 2. Such household surveys provide the most important and widely used method of obtaining demographic, social and economic information for individuals and households in rural areas of developing countries (Carpenter & McGillivray, 2012, p.31, La Rovere & Dixon, 2007, p.11). They tend to result in richer information on livelihoods and living standards than macro-economic data and are very useful for (policy) recommendations. Carpenter & McGillivray's (2012, p.31) advice is to include the elements presented in Table 1 in an evaluation of a household survey in order to assess the impact on the livelihood of farmers adequately.

Demographic Data	Household consumption, including gender, ages, years of schooling and details of the head of the household
Livelihood	Natural capital: land area, quality of land, quality of access to water, land tenure
Assets	Financial capital: household income from different sources, sources of credit and savings
	Physical capital: ownership of, or access to agricultural machinery, presence or absence of irrigation, housing conditions
	Social capital: membership of local organizations (e.g. farmer groups) and local agriculture-based institutions (e.g. labour exchange institutions, rotating credit and savings associations)
	Human capital: formal education, agricultural training, household labour force availability and health details
Livelihood Strategies	Details of seasonal agricultural production: questions would be specific to the mode of production that was the target of the agricultural research. Include timing of agricultural tasks, use of the products, yields from modes of production, average productivity, revenue from agriculture and from different modes of production, etc.
	Details of other non-agricultural household strategies: questions detailing the relative importance of non-farm livelihood strategies (e.g. off-farm employment, seasonal labour, remittances, short-term migration.

Source: Carpenter & McGillivray, 2012, p.31

Key informant interviews:

Furthermore, key informant interviews were conducted with a series of stakeholders and involved parties. Key informants are people who are willing and able to provide in-depth insights into important aspects of the research, such as early adopters, community elders, government extension workers, national and international policy officers, agricultural researchers, NGO workers or private sector employees (Carpenter & McGillivray, 2012, p.35). The qualitative information obtained through these interviews is a useful complement to data collection from household surveys (Carpenter & McGillivray, 2012, p.35).

In this regard, the technicians of CAV were interviewed during 90 minutes on the activities, the intervention and challenges in the region (Souza de Almeida & Souza, 2014). Furthermore, as part of this study the author visited a governmental organization implementing the same type of technologies in a different municipality in order to analyze the differences between CAV's and other organizations' work (Matos, 2014). A third important element of the key informant interviews builds a discussion with representatives of the research centre *Apoio à Agricultura Familiar* (Núcleo PPJ) of the Federal University of Lavras (UFLA) (Galizoni et al., 2014). The objective of these interviews was to elaborate a more holistic picture of the region.

1.4.3. Definition of Sample

The impact analysis of the interventions made with VM's investments was conducted in the communities of Gameleira, Monte Alegre (both belonging to the municipality of Veredinha), Morro Branco and Cuba (both belonging to the municipality of Chapada do Norte). The communities of Macaúbas, Pontezinha and Corrego da Rocha were not visited due to its resemblance with one of the four visited. A more detailed project description can be found under section 3.

From a total of 151 beneficiaries of RWH technologies, a sample of 28 families benefitting directly from the interventions was chosen randomly for interviews. Hence, the poll consists of 18.54% of the total number of interventions (28 out of 151 = 28/151). The size of the sample can be justified with the limited dimension of the master thesis.

The number of families per community was defined according to the following criteria:

- Number of interventions in community: Relative to the total number of interventions with VM's investments.
- Time span: Distribution according to duration of the intervention in order to analyze a representative sample for all the years from 2009 2013.
- Type of intervention: Including water harvesting ponds as well as smaller basins.
- Gender: Including, if possible, a similar number of male and female beneficiaries in the sample.

Furthermore, two families without any type of direct intervention were interviewed in order to have an outsider view of people not targeted directly but benefiting from the installation through the infiltration downstream and CAV's engagement in the community.

The primary data of the household survey and the key informant interviews was evaluated by the author and complemented with an extensive literature review on published papers and books on the rural development of the Alto Jequitinhonha. Such secondary data is important to provide a good overview on the general trends in the region (Adato & Meinzen-Dick, 2002, p.33). With existing sources of studies previously conducted by different institutions, the data is abundant. Other authors have pursued the same methodology of primary and secondary data collection in order to develop research on the region (Mendoça et al., 2013, p.446; Ribeiro et al., 2007, p.1078; Ribeiro et al. 2014, p.367).

1.4.4. Limitations

The study itself has a certain limitation. CAV did not only build water harvesting ponds and basins, but elaborated a complex network of programs and actors through its activity, enabling the development of the region. As the Alto Jequitinhonha is a region where a lot of projects are executed, many governmental and non-governmental investments flow to CAV and other institutions. Especially the implemented governmental programme *Fome Zero*, the governmental zero hunger strategy, has a strong impact on the revenue of most families (Ribeiro et al., 2014, p.367). In the following part on the context and transforming structures and processes, the supportive Brazilian public policies will be taken up in more detail. Hence, it will not be possible to eliminate all the measurement problems existing in the field of socio-economic analysis.

Certain difficulties were encountered while conducting the interviews. In some cases precise data turned out to be rather difficult to collect. On the one hand, accountancy is not (yet) a commonly used method to keep track on the sales and consumption in a household (Ribeiro et al., 2014, p.367). This induces that the exact size of production is difficult to assess. Hence, the precise income of the families is very complicated to detect. On the other hand, the humble families also feel some constraints to talk about their revenue or personal belongings of value. In order to overcome these difficulties, primary data collected through the bookkeeping pilot project of CAV supported the estimation of average income.

2. Context of the Alto Jequitinhonha

In this section the objective is to draw a picture of the Vale do Jequitinhonha. The historical background of the region and the initial situation the farmers were exposed to enables the reader to understand the missing access to assets. CAV's engagement and some governmental policies manage to improve this access and shape the livelihood of the families. The SLF will serve as a conceptual model in order to better explain the particularities of the region and the organization. As Figure 1 shows, the vulnerability context, the livelihood resources (assets), the institutional context and the livelihood strategies are elements of this analysis.

2.1. Vulnerability Context, Asset Management and Livelihood Strategies

2.1.1. Lack of Natural Assets Water

The initial Vulnerability Context ranges largely outside the control of the poor and is also a consequence of missing livelihood assets. The very negative connotation *valley of mistery* is a product of environmental degradation, decreasing water availability and, as a consequence, limited agricultural production. The valley is classified as a semi-arid zone, thus water has always been an element of constant dispute (Zhouri, 2013, p.12). The region is divided into two different geographic zones; the Alto and Baixo Jequitinhonha (high and low Valley of Jequitinhonha) (Ribeiro et al., 2007, p.1080). The study focuses exclusively on the region of Alto Jequitinhonha, marked in yellow, where CAV is particularly present and active.



Figure 2: Map of Vale do Jequitinhonha Source: Wikipedia (2015) – Mesoregião do Jequitinhonha

Due to the aggravating situation of water availability, the families and farmers native to the rural area of the region organized their life around water springs (Galizoni, 2013, p.19). Over time, these communities living in this complex context managed to develop a whole ecosystem around the use, regularization, distribution and conservation of water (Zhouri, 2013, p.12).

The difficulties of access to assets and the subsequent vulnerability of farmers have different origins. Land and water became the object of desire for the private sector as well as of the traditional inhabitants of the region, the small-scale farmers. This was mainly provoked through the modernization of agriculture and the strong focus on commodity production, incentivized by the Brazilian government in the 1960s/1970s (Ribeiro et al., 2007, p.1081). The lack of water, a physical and natural asset, caused a disruption in the regional economy. The rapid transformation of the water cycle is a consequence of excessive use by human beings (Pereira Lima, 2013, p.98). Furthermore, the government established several hydroelectric installations in the region, flooding fertile land and expulsing residents. The disproportionate exploitation and destruction of water resources is only one negative effect the entry of the multinational companies had. Smallholders could hardly manifest their discontent against the new players invading the region and claim their land (Ribeiro et al., 2007, p.1084). With the increasing demand for both limited natural resources, a tendency of depletion set in and rapidly led to a vicious circle (Galizoni, 2013, p.35). The governmental efforts to protect the legal claims of property of the rural population were limited. Furthermore, the whole region was heavily exposed to environmental degradation. The scarcity of land for agricultural use led to plantations in the formerly untouched hills. Soil erosion as a consequence of deforested slopes or a reduction of biodiversity due to the monocultures further disfavoured the environmental equilibrium and turned the region into a challenging area for agricultural activities from a natural asset perspective (Galizoni et al., 2013, p.94-95). Actually, the region's environmental degradation is considered to lie at the origin of the problems of the Alto Jequitinhonha (Galizioni, 2013, p.21). Furthermore, other authors state that water scarcity is a direct consequence of climate change (Hanjra & Qureshi, 2010, p.367). In this sense, Figure 3 shows us more rainfall in the months of November and December but also indicates a higher concentration on these two months. The rest of the year, though, tends to be dryier (Kuntner, 2014, p.45; Souza de Almeida & Souza, 2014).



Figure 3: Concentration of monthly rainfall in Turmalina Source: Kuntner, 2014, p.45

As a consequence of water scarcity not only agricultural production or the maintenance of livestock became more complicated, but the families also suffered from reduced physical access to water for their household. Thus, the physical asset was missing. In many cases, they were obliged to ask the municipality to send a *caminhão pipa*, a water truck, in order to fill the cisterns. Besides the feeling of helplessness, the families also had to cope with long waiting periods and a deteriorating water quality. From a psychological point of view the access to water is extremely important for the farmers of the region. They have a very close relationship to springs and to water streams, as it is vital not only for their agricultural production and survival, but also for their organizational structure of the family (Galizoni, 2013, p. 92; Pereira Lima, 2013, p.98). Additionally, the aspect of underdeveloped infrastructure led to a stagnation of the region. Until the end of the 1990s electricity had rarely reached the rural areas of the communities of Veredinha and Chapada do Norte; paved roads as well as public transport are still rare in the region.

2.1.2. Difficulty in Creating Economic Assets Locally

The disruption of the traditional water cycle had profound impact on the economic activity and the way of accumulating stocks and granting regular inflows of money. In general, during the dry periods, the farmers had to limit food production. This meant a decreasing income, a more restricted diet and an increase in spending for alimentation (Galizoni et al., 2008, p.138). Hence, food security and the access to financial assets varied according to the period of the year. The inflow of money generated through agricultural activity was clearly higher in the rainy season. Furthermore, the effects of the governmental policies in the 1960s/1970s had a profound influence on the economic structure of the region. Given the production on a large scale of producing beneficiaries of the public policies, the smallholders in the Vale do Jequitinhonha were not able to compete with the prices anymore and the agricultural production became less relevant (Ribeiro et al., 2007, p.1082). As a consequence, the revenue granted by local food production for the individuals tended to be nearly inexistent.

Thus, as a continuously evolving trend, by the end of the 1980s the Alto Jequitinhonha was characterized as a region home to many communities consisting of large families with a fragmented possession of land and a significant seasonal migration flow towards large plantations in other regions of Brazil, mainly the south of Minas Gerais and São Paulo (Galizoni, 2013, p.29). In the context of the Alto Jequitinhonha people historically compose and complement their livelihood strategy with an important income generated through the seasonal migration (Galizoni, 2000, p.7). Such cultural peculiarities do strongly influence the behaviour of people in the region and their relationship towards agriculture and their own production.

2.1.3. The Exodus of Human Capital Despite Presence of Social Capital

The assessment of human capital is very peculiar in the context of the Alto Jequitinhonha. Knowledge as well as certain unwritten rules in relation to the use of water have been transferred over generations and thus the ability to work under difficult circumstances has been incorporated by the population of the valley (Mendoça, 2013, p.452; Ribeiro et al., 2014, p.379). Hence human capital was always present but not necessarily measurable through the commonly used indicators of education. Nevertheless, the rural exodus certainly had a negative impact on the human capital present in the region (Mendoça, 2013, p.449). Many farmers left the region in order to seek new opportunities elsewhere. Furthermore, the low level of schooling and alarming situation of public health care did certainly not stimulate the development of the human asset (Tupy, 2013, p.2).

According to key informants, the horizontal network within a community was always intact (Galizoni, 2000, p.11). This might be a result of historically developed close familiar ties (Ribeiro et al., 2007, p.1078). Hence one can assume that the members of the communities

always had considerable access to social assets. The livelihood strategy was very much based on confidence and trust in neighbours, family and community members (Ribeiro et al., 2013, p.47). Nevertheless, water scarcity managed to provoke a complex social trend. This mainly refers to the prioritization of water use in daily life for personal use or agricultural production and maintenance of livestock (Galizoni, 2013, p.146). Even though the communities have some unwritten rules and general consciousness on water consumption, conflicts within communities cannot be categorically excluded (Galizoni, 2013, p.135).

The cultural customs of family farming, the productive activity and other elements were affected deeply by the invasion of the corporations (Ribeiro et al., 2007, p.1087). The 1980s were characterized by the formation of groups supporting the cause of the families traditionally home to the region. With the emergence and manifestation of religious institutions, syndicates and NGOs, people started advocating for the rights of the rural poor (Ribeiro et al., 2008, p.1086;). Such organizations started to strengthen the social asset within communities, grouping the farmers and manifesting their interests. As a reaction, the rural population themselves rearranged them according to the new structures and processes.

2.1.4. Livelihood Strategy Under Challenging Circumstances

The natural asset water poses a challenge to the smallholders of the Alto Jequitinhonha. The access to this asset can be considered to be the most essential capital of farmers. As a consequence of the high dependence on the water cycle, the limited economic opportunities and the relative stagnation of the region, the livelihood strategies were very often composed by a seasonal migration of young men and sometimes women to assure the access to financial capital (Galizoni, 2000, p.10). The governmental policies in favour of big corporations indicate that the transforming structures and processes were not favourable for a positive development of the smallholders' livelihood in relation to the permanence in the region. The social cohesion can be considered an element absorbing the limited opportunities in the region. Most of the communities had always disposed of clear priorities when it came to the use of water. According to a study of Galizoni et al. (2013, p.136), priority was always given to the domestic use of water, for drinking and cooking purposes, for instance. As second most significant utilization of water, the farmers normally named the use for livestock creation. Third is ranked the agricultural production with its vegetable garden and the least importance was given to domestic rural industry. It can be deduced that once water was not abundant anymore, the self-sufficiency was at risk and had to be compensated with seasonal migration or other professional activities in order to guarantee food security. The livelihood strategy in this environment was strongly adapted to the farmers' vulnerability and to the circumstances presented by the unfavourable conditions, affected by shocks, trends or seasonalities.

2.2. Transforming Structures and Processes in the 1990s

People report from the 1970s that the region was associated with a delay in development. By the 1980s, a book mentions the "paradox of poverty" in the region, and another decade later the Alto Jequitinhonha is characterized by missing health assistance, lack of energy, education, infrastructure and jobs as well as low agricultural production (Ribeiro et al. 2014, p.366). However, over the past twenty years the situation improved for smallholders. Certainly the pressure of civil society and the rural poor has incentivized the government to take action against the alarming situation in the Alto Jequitinhonha. Both, government and civil society, contributed to a positive development of the region.

2.2.1. Governmental Policies

The national government officialized the status of family farming and the state of Minas Gerais created a subdivision in the ministry of agriculture representing the interests of smallholders in 2011 (Ministério de Agricultura Minas Gerais, 2011). Furthermore, the federal government introduced a series of important public policies (Ribeiro et al. 2014, p.367). The most important governmental programmes transforming the structure and processes for smallholders in the Vale do Jequitinhonha can be divided into two different intervention axis of policies (Aranha et al., 2009, p.8). The first aims at providing instruments for smallholders to improve the production (production policies) and the second forms part of cash transfer policies. The overall strategy is called *Fome Zero*, a cross-sectional package of different programmes promoting the development in the rural and poor areas of Brazil and it aims at providing food security (Leão & Maluf, 2012, p.53, Medaets, J.P. et al., 2003, p.9). The objective is to assure quantity, quality and regularity of alimentation for all Brazilians (Suplicy, 2003, p.63).

2.2.1.1. Production Policies

From a production perspective, for the smallholders an important element of *Fome Zero* is the *PRONAF*. By 1994 the Brazilian authorities together with FAO created the PRONAPV, which one year later turned into the PRONAF (Guanziroli & Basco, 2010, p.45). It consists of a credit programme exclusively for family farmers, supporting mainly food production (Aranha et al., 2009, p.33). Loans are granted for infrastructure reinforcement on the property

and investment in production factors. Different lines of the credit were created, amongst other special conditions for young farmers or women (Guanziroli & Basco, 2010, p.50). It has to be mentioned, that only in 2006 the PRONAF started disseminating in the Alto Jequitinhonha (Ribeiro, 2014, p.367). The objective of the programme is to turn the families into self-sufficient farmers, a crucial factor for reducing hunger and vulnerability.

A second important measure to increase the production of smallholders in line with *Fome Zero* is governmental investment in cisterns for water storage. The programme called *P1MC* (programme 1 million of cisterns), is coordinated through the *ASA*, articulação semi-arido brasileiro, and aims at providing water for human and domestic use (UNDP, 2007, p.205). The goal is, as the name of the programme reveals, to build one million cisterns in the semi-arid region. Since 2003 the government already provided almost 500,000 cisterns, attending two million beneficiaries (ASA, 2014). The final objective of the cistern is to contribute to a creation of a regular income of smallholders in the semi-arid zones (Suplicy, 2003, p.64).

2.2.1.2. Cash Transfer Policies

In the mid-1990s the Brazilian government started to implement cash transfer policies. By 2003 the *Bolsa Familia*, a well-known social welfare programme for the poor, consolidated four different types of policies into a single one (Soares, 2012, p.1). The aim of the programme is to promote schooling, health care, food consumption and compensation for government subsidies (Lindert, 2006, p.1). In 2013 *Bolsa Familia* reached over 50 million Brazilians and was thus one of the most significant poverty reduction policies worldwide (Schwarzer, 2013, p.1). On the one hand, there is the short-term goal of reducing poverty through redistribution and, on the other hand, the long-term objective to incentivize the poor to develop their human capital (Lindert, 2006, p.2). The programme is also part of the *Fome Zero* strategy.

Beneficio de Prestação de Continuada is another significant form of cash transfer in form of pensions for the rural population. In 2014 it amounted to R\$ 714 and it is not necessarily dependent on previous employment. Even without previous contribution, every citizen can claim the pension when turning 65 (Tupy & Toyoshima, 2013, p.14). If the person contributed a certain amount of years to the fund, it can claim the cash transfer, too. Another group of people allowed to receive the compensation are the disabled (IPEA, 2010, p.15-16). The objective of such a measure is to reduce poverty and inequality (Tupy & Toyoshima, 2013, p.3).

Those policies have contributed significantly to poverty eradication by transforming the structures and processes affecting the livelihood of the poor. In many cases the income received through the cash transfer policies is the only constant source of revenue guaranteeing the family's survival (Tupy & Toyoshima, 2013, p.14).

2.2.2. Centro de Agricultura Alternativa Vicente Nica (CAV)

An institution involved in the whole process of transforming structures and processes is the beneficiary institution of VM's investments. CAV was founded in Turmalina (Minas Gerais) in 1994, 20 years ago, with the intention to represent the interests of the rural population in the Vale do Jequitinhonha (CAV, 2014). The objective is to discuss, formulate, experiment, suggest and realize activities adapted to the social, economic and environmental characteristics of the region. CAV seeks to consolidate the local knowledge and culture with innovative technologies (Ganzioli, 2013, p.160). Through their engagement, the NGO aims at reducing poverty in the rural area of the region and at improving the small-scale farmer's life quality. During the visit, a considerable amount of information was gathered on the activity of the NGO and the conducted key informant interviews contributed to the compilation of this section.

2.2.2.1. Improving Access to Natural Assets

CAV has recognized the importance to tackle the issue of water scarcity and puts it at the core of its activities. The organization has developed a product portfolio according to the different realities in the communities and to the diverse goals of financing institutions or governments. In order to improve the farmer's access to water, CAV implements a series of revitalization projects through RWH techniques. The aim of such techniques is to collect and store runoff water, which otherwise could not be used (Mekdashi Studer & Liniger, 2013, p.4). With the support of the Swiss foundation VM, CAV promotes mainly three types of technologies:

Macrocatchment Water Harvesting Ponds: CAV builds *barraginhas*, water harvesting ponds with the objective of infiltration and water storage for agricultural production, essential for cultivation and maintenance of livestock (Mekdashi Studer & Liniger, 2013, p.8). During the rainy season, the pond fills up with water, which then is used during the dryer periods. An important function of the pond is the infiltration of water into the soil (De Barros & Ribeiro, 2009, p.11). Through infiltration, the groundwater

level is supposed to rise; as a consequence, the soil tends to become more humid and the water level in wells increases, too.



Figure 4: Illustrative Macrocatchment Water Harvesting Pond Source: Mekdashi Studer & Liniger (2013, p.11)

For the construction an excavation made by a dozer lasts up to twenty hours (see Appendix 12). CAV's technicians are normally present when undertaking the construction in order to support the dozer conductor in finding the adequate composition of the pond's ground, essential for the process of infiltration. The pond normally has a volume from 200 up to a few thousand cubic metres (Kuntner, 2014, p.20). The excavated material is used to build a dam retaining the water. Furthermore, the water harvesting pond is protected by fences and plants, mainly in order to avoid invasion of animals.

- 2) Microcatchment Water Harvesting Ponds: The so-called *bacias* are smaller water basins retaining sediments and securing rainwater for infiltration. They are often built close to the roads or on steep slopes with the function of protecting the bigger water harvesting ponds from eroding material (EMATER, 2006, p.2). The construction of the basin is an excavation similar to the bigger water harvesting pond. It can take five hours and it is up to four meters deep with a diameter of maximum twenty meters (Kuntner, 2014, p.20).
- 3) Diques: Diques are small dams built out of cement. This intervention figures in CAV's portfolio since 2013 as a reaction to the challenging geological and topographical circumstances in Chapada do Norte. The dams are built by a joint work input by farmers (see Appendix 12). The harvested water through the three technologies built with VM's investments is mainly used for agricultural production.

Furthermore, CAV also implements other measures in order to protect or revitalize the water streams in the region, supported by other sponsoring organizations or governmental institutions.

- Headwater and spring protection: This type of intervention is one of the first methods CAV implemented by the end of the 1990s (Galizoni et al., 2013, p.159). The aim is to revitalize and to strengthen the endangered water source, which is considered water of good quality by the farmers of the region (Freire, 2013, p.67). For the protective measures, the NGO empasizes the importance of communitarian work and cooperation in order to assure the ownership component (Galizoni et al., 2013, p.160).
- 2) Wells: CAV also possesses experience in the construction and maintenance of artesian wells. The objective of the wells is to facilitate the access to water. Often such installations are constructed down stream of water harvesting ponds (Souza de Almeida & Souza, 2014). The infiltration of water harvesting ponds, for instance, leads to a rise of the groundwater level and therewith increases the availability of water for the families in the wells.
- 3) Courtyard Water Harvesting: In areas with more challenging soil and topographical conditions, CAV also builds large and slightly slopy cement catchments capturing the water and channelizing it into cisterns (ClimaTechWiki, 2014). The storage water can be used for agricultural production.
- 4) Rooftop Water Harvesting: The aforementioned P1MC aims at facilitating water storage through the installation of water tanks with a volume of 16'000l (de Paula Assis, 2013, p.207-208). The water is mainly collected from rainfall on the rooftops.

The last programme is financed by the government but executed by CAV and other NGOs. Additionally, the government also builds small harvesting ponds, artesian wells, provides the population with water tanks or builds water pipelines supplied with water from rivers (Galizoni, 2008, p.146).

A different institution visited by the author of this study is the *Projeto Barraginhas*, in order to have a comparison on how other players proceed. The organization emerged as an NGO and nowadays constructs water harvesting ponds for the Brazilian government. In the first period of the project lasting from 2005 to 2011, *Projeto Barraginhas* built around 1'000 slightly smaller water harvesting ponds in the municipality of Minas Novas, geographically lying in between Turmalina and Chapada do Norte (Matos, 2014). Thus, the governmental project implemented more than two times the constructions over a period of four years

compared to CAV. However, the fundamental difference between the *Projeto Barraginhas* and CAV is the attention the farmer gets. While the governmental project has one technician attending all constructions, CAV provides four to five for a much smaller amount of beneficiaries.

The holistic approach of the organization propagates a very balanced and conscious use of natural assets. The farmers are incentivized to use natural fertilizers, such as chicken dung or other livestock residuals. CAV notably tries to influence the farmer's mode of production towards a more sustainable conduct of agricultural use of the soil (Noronha, 2008, p.30). In this respect, the NGO stimulates the exchange of traditional seeds from the region in order to preserve the richness of biodiversity adapted to the local peculiarities. As one of the positive consequences, the smallholder becomes less vulnerable to increasing crop prices and has lower expenses. Furthermore, the optimization of the use of resources is a permanent topic when trying to improve the livelihood assets. The exchange also strengthens the ties between the community members and develops knowledge about traditions.

2.2.2.2. Creation and Transfer of Human Capital

The organization also aims at developing human capital by complementing the farmer's knowledge of sustainable agricultural production and cohabitation with the nature (CAV, 2014). CAV's employees, the technicians, build the cornerstone of the development of the human asset linked to agricultural production in the region. Summarizing in one sentence, the technicians execute the organization projects in the communities and are responsible for the construction of the RWH technologies. All of them possess significant knowledge in agriculture and dispose of a personal experience in the topic. This includes growing up in the farm as a child, as a teenager and young professional. Some pursued studies in agronomy or possess a small property in the region. The technicians' activity consists of numerous and diverse tasks in relation to the planning, implementation and evaluation of the above mentioned intervention portfolio of RWH methods in order to assure the availability of the natural asset. The technicians bring along a very profound knowledge about the social, cultural, economic and productive reality of the region. Besides the task of implementing all the RWH technologies, the technicians coach the farmers on the properties. They transmit relevant information to the smallholders concerning sustainable practices, more efficient use of resources or product diversification.

Furthermore, CAV offers various trainings and courses to different target groups. The young members of the families, normally from 13 to 17 years old, have the possibility to join the Escola Família Agrícola Veredinha (EFAV). The EFAV offers an educational methodology based on the agricultural traditions of the region. The aim is to promote the possibility for young people to develop knowledge in agriculture. Classes and practical exercises take place on the school campus. Apart from providing an alternative education to the common secondary school in Veredinha, the school's objective is to incentivize the youth to get in touch with agriculture, to countervail the seasonal migration and to reduce the rural exodus (EFAV, 2014). This initiative is supported financially through VM. Since 2012 the foundation has invested CHF 239'778 in the agricultural school. Furthermore, CAV organizes trainings related to specific agricultural activities.

When benefiting from a technology, the farmer is obliged to participate in trainings related to water management and installation maintenance. Furthermore, the NGO offers courses in relation to agriculture. Examples are courses on apiculture or methods on how to treat certain plants in order to prevent and fight diseases. Additionally, ways of efficient and cost-saving irrigation or more sustainable practices are taught to the families. An important target group of CAV's engagement are women. The organization, jointly with VM, considers an empowerment of the female population as a crucial element in the sustainable development in the Alto Jequitinhonha (CAV, 2014). Thus, CAV periodically organizes workshops related to rural activities for women. This includes possibilities to learn how to process agricultural goods in an artisanal manner. Furthermore, community reunions are organized in order to inform, sensibilize and make women aware of their rights. The groups are also created to incentivize the exchange of experiences and to stimulate the debate amongst them.

2.2.2.3. Forster the Development of Social Assets

The formation of such groups has a considerable impact on the development of social assets in the region. CAV originally emerged out of a labour organization, which still has a very notable influence on its activities. Gathering farmers and other relevant stakeholders around the common goal of rural development is at the core of the organization's mission. Before implementing the activities and interventions in the rural area, CAV always assembles the whole community in order to discuss the setting and the best solution for the group of direct and indirect beneficiaries (Souza de Almeida & Souza, 2014). Thus, the process is designed in a very participative manner. This is also reflected pertaining to the actual implementation of the RWH technologies. The communities are obliged to provide a financial and physical counterpart. They cover five per cent of the intervention with their own financial capital. Furthermore, the members of a village actively help building dams or protecting the springs. These measures stimulate a constructive and result-oriented dialogue in the community and automatically imply an ownership component of the intervention. The DFID (1999, p.14) stresses in its Guidance Sheets the importance of such a participative construction of physical asset. Additionally, the contribution to the construction of such technologies transfers important knowledge to the farmers. Learning-by-doing does not only evolve the consciousness of the beneficiaries, it can also stimulate them to maintain and develop the installation further according to the needs of a family. Thus, the development of human capital through the social activity of CAV is not to be underestimated.

The creation of the market association in Veredinha, for instance, is a very representative case for this engagement. VM co-financed a project called *A lively market for Veredinha* with the objective of developing and strengthening the market association in order to stimulate a local commerce. CAV first assembled the potential communities benefiting from the association, analysing their needs and desires. In a second step, the whole organization was structured and the involved families had to occupy the vacancies, such as treasurer or president of the association. Once the market association in Veredinha was sufficiently structured and proved its operability, CAV was able to reduce its engagement. The responsibility was handed over continuously to the benefiting communities.

2.2.2.4. Sales Channels and Access to Financial Assets

Furthermore, the case of the market illustrates how the NGO tries to improve the access to financial assets. Developing new sales channels for the population is crucial in order to facilitate the cash inflow of the families (Ribeiro et al., 2013, p.44). However, the cornerstone of access to financial assets is the improved agricultural production. As already stated above, CAV promotes the agricultural activity through the establishment of the technologies in order to revitalize the region and to offer the population relevant production factors. Furthermore, the organization also established a *fundo rotativo*, a fund enabling the farmers to have access to credits in order to improve the cultivation of certain products, to facilitate the livestock breeding or even to enable investments in the processing of specific goods. Another objective of the fund is to stimulate collective community purchases of organic fertilizers by reducing the total costs. More recently CAV started the pilot project of basic household accounting with some families. The organization coaches the selected farmers in bookkeeping and evaluates the data of family consumption, sales through the diverse channels, donations to

other community members and exchanged goods. As a hypothesis, CAV might stimulate entrepreneurship through the mentioned introduction to household management and the development of a certain consciousness of the availability of financial assets. The farmers might discover an additional value in its agricultural production through this awareness of financial returns on its productive activities, formerly mainly associated with the notions of survival and food security.

As mentioned in the theoretical part, physical capital interacts very closely with the other four assets considered by the SLF. Through CAV's engagement in the water sector, the intentions to improve the physical access to the scarce good are visible. For many families, the tangible RWH installation perceptibly improves water availability. Apart from the improvement of access to financial capital, the fund also concedes credits for the acquisition of livestock and thus provides access to physical capital. Through the EFAV, CAV has improved the possibilities of young people to pursue their studies. The access to education was also made possible through the provision of transport. The municipalities were engaged in such service provision and thus contribute considerably to a better access to physical capital.

2.2.2.5. Assembling and Engaging Stakeholders

CAV is undoubtedly part of the transforming structures and processes. The example of EFAV is very adequate to illustrate the organization's engagement with regard to the shaping of the families' contextual environment. The school was built with capital from international donations and started its operation with funds from abroad. However, CAV managed to incentivize an engagement of the municipality of Veredinha, for instance. The dialogue between the NGO, other organizations and governmental institutions builds a fundamental part of CAV's activity. Not only the communities but also local government has to provide a counterpart in the projects of CAV. In the case of the construction of water harvesting ponds or basins for a certain community, the municipality contributes with operational help, hiring the dozer for additional hours. Public-private-partnerships are incentivized by successful pilot projects, such as the above-mentioned P1MC. Collaboration is also needed with respect to the establishment and development of local markets, where municipalities, donors and CAV play a very important role.

Another meaningful strategic cooperation is the partnership with the research centre Núcleo PPJ of the Federal University of Lavras and other academic institutions. The PPJ has been accompanying the activities of CAV for more than fifteen years. During this period the
research centre elaborated numerous studies and articles on the organization as well as on the region (Ribeiro et al., 2013, p.39). This enables the organization to demonstrate its importance for the region and, as a consequence, it can advise and exert pressure on public institutions (Ribeiro et al., 2013, p.44).

The section on the methodology of CAV's activities, projects and partnership allows us to better understand the aim to improve the farmer's access to assets. The holistic approach of the organization demonstrates that the RWH technologies are only part of the puzzle contributing to the rural development in the Alto Jequitinhona. The environment as a whole, including farmers, sponsors, partners and governmental institutions, is shaping the livelihoods of the families.

3. Project Description

The extensive analysis through the SLF includes more elements than just the investments of the Swiss foundation VM and aims to identify general trends in the Alto Jequitinhonha. However, the objective of this study is to evaluate the socio-economic impact of the construction of water harvesting ponds and basins. As a consequence, it is fundamental to describe the different projects, general conditions and peculiarities of the communities in order to have a consistent overview.

3.1. The Projects

The projects financed by VM can be divided into two distinct municipalities over two different time periods. In a first phase, from 2008 until 2012, a special attention was given to the municipality of Veredinha, about 15 kilometres away from CAV's headquarter in Turmalina. During the five years, two different projects were financed. The engagement started with a project named *Water for Gamileira* (2008 – 2012). Furthermore, the municipality of Veredinha benefitted from a project called *Increase in Production for Macaúbas*, running from 2010 until 2012. Both projects aimed at building water harvesting ponds and basins in the communities of Gamileira, Macaúbas, Monte Alegre and Pontezinha. Due to a very low number of beneficiaries in 2008, only farmers with constructions built between 2009 and 2012 were interviewed for this study.

In a second step, the municipality of Chapada do Norte was included in the activities of CAV. The project called *Female Smallholders and Income Security* started in 2012 and is still ongoing. Chapada do Norte lies 70 kilometres north of Turmalina. Besides the construction of RWH technologies, the project's objective is to empower the female population of the municipality. The targeted families are home to the communities of Cuba and Morro Branco.

It must be mentioned that these communities (and projects) present some very different realities, geographically, geologically and socially speaking. As a consequence, the engagement and approach of CAV in the different communities has to be adapted according to the local conditions. Figure 4 provides an overview on the geographic location of the two municipalities benefitting of the NGO's engagement.



Figure 5: Location of CAV's activity

Source: CAV (2014).

In terms of infrastructure, the village of Veredinha presents a much more developed situation than Chapada do Norte. On the one hand, the access routes are mostly paved and the distance to the city of Turmalina, with a vivid commercial life, is not very large. Chapada do Norte, in turn, lies rather isolated with difficulties in public transportation and access. Thus, due to the geographical distance and the lack of infrastructure, Chapada do Norte tends to be economically less developed.

Geologically, the team of CAV did not encounter the same favourable circumstances in Chapada do Norte than previously in Veredinha. The slopes in Chapada do Norte are much steeper, which turns the construction of water harvesting ponds more complicated, due to the smaller volumetric capacity. Furthermore, the soil seems to present a more challenging reality than in Veredinha. The pattern of infiltration is different due to the material consistence of the soil, which makes water retention more difficult (Souza de Almeida & Souza, 2014). This, amongst others, led to the innovative idea of including cement diques in the portfolio of RWH technologies. Furthermore, it has to be highlighted that rainfall in the Alto Jequitinhonha can be very local. Normally, the rainy season lasts from November until March (Galizoni et al. 2013, p.139). When visiting the region in July 2014, the community of Gamileira (Veredinha) had had its last rainfall in December 2013 and no raindrop has fallen

since. The community of Morro Branco, though, had had some unexpected rain in the month of May. Thus, the conditions in relation to the production and water availability are very local. This might have an influence on the result of the study.

It might surprise the reader but even though they are only 80 kilometres away from each other, culturally, the municipalities present a very diverging scenario. Whereas the communities of Veredinha are composed of descendants of Europeans or indigenous people, the communities of Chapada do Norte are mainly quilombola communities. They represent the population of former fugitive black slaves (Biazzi de Abreu, 2010, p.4). When slavery was abolished in Brazil by the end of the 19th century, many communities established close the division between Minas Gerais and Bahia. Hence, comparing the two communities, the behavioural aspect of people is very different. The attitude as a result of the inferior position over decades or even centuries is still noticeable in the municipality of Chapada do NOrte (Silveira, 2012, p.1). As a consequence, quilombola people tend to be rather hesitant towards new ideas and methods. The quilombolas are often characterized as submissive, but solidarity within the community is very important (Biazzi de Abreu, 2010, p.4). Hence the communities dispose of values strongly associated with the quilombola tradition. CAV's technicians are natives from the region of Turmalina or Veredinha and thus more intimate with the culture and social organization of the communities belonging to the latter municipality.

In general, an external and neutral observer would assume that the conditions in Veredinha tend to present a more favourable environment to the interventions of CAV than Chapada do Norte. Nevertheless, the lower degree of development of the communities Cuba and Morro Branco can offer a lot of opportunities for rapid growth.

3.2. The Investments of Vivamos Mejor

Investments of international donors should contribute to speeding-up regional development. As illustrated in Table 2, the total investment of VM between 2009 and the end of 2013 in the region amounts to CHF 885'089.

	2008	2009	2010	2011	2012	2013	Total 08 - 13
Water for Gamileira	CHF 13'845	CHF 62'517	CHF 89'833	CHF 61'840	CHF 36'731		CHF264'766
Production Macaúbas			CHF 80'649	CHF 85'405	CHF 60'962		CHF227'016
Female Smallholders					CHF 37'182	CHF 84'810	CHF121'992
EFAV				CHF 76'989	CHF 92'568	CHF 70'221	CHF239'778
Market Veredinha						CHF 31'537	CHF31'537
Total Amount							CHF885'089

Table 2: Investments of Vivamos Mejor in the Alto Jequitinhonha

Source: Vivamos Mejor Suiza (2014).

VM supports with its investments a broad range of projects targeting the improvement of access to all five assets previously elaborated. Our main focus lies on the impact of RWH methods on the socio-economic well-being of the beneficiaries. Hence the sum of invested money in RWH methods; thus, line 1, 2 and 3 will be the amount considered for the economic payback calculations. The in total CHF 613'774 are investments in the planning, the construction and maintenance of the water harvesting ponds and basins. Furthermore, the money covers the project management in Brazil as well as in Switzerland, the operational costs, the technicians with their consulting function and the communitarian work for productive questions. Additionally, the investments enable the execution trainings and courses. In the case of the project *Female Smallholders and Income Security*, the budget also contributes to communitarian work with women.

Our aim is to define the impact the investments in technology and in the NGO's activity have on the agricultural productivity, how this affects the financial output of the activity, the social changes it provokes and how it shapes communitarian life. In total, 104 families benefited from interventions of the project *Water for Gamileira* and *Increase in Production for Macaúbas* in the communities of Gamileira, Macaúbas, Monte Alegre and Pontezinha. In the second project in the municipality of Chapada do Norte, the interventions reached a total of 47 families. The number of beneficiaries per community with the year of the intervention is listed in the table below.

		2009	2010	2011	2012	2013	Total
Veredinha	Gamileira		8	9			17
Chapada do Norte	Macaúbas	8	9	15			32
	Monte Alegre	10	10	15	2		37
	Pontezinha			14	4		18
	Morro Branco				13	14	27
	Cuba					20	20
	Total						151

Table 3: Beneficiaries according to communities between 2009 and 2013

Source: Data CAV (2014).

Out of the 151 families assisted, 28 were interviewed during the field visit. The higher number of beneficiaries in the municipality of Veredinha was taken into account when chosing the sample. 18 families, whereof two indirect beneficiaries, were interviewed in this municipality. In the municipality of Chapada do Norte twelve families were visited. Both indirect beneficiaries live downstream of the interventions and thus benefit from the humidity of the soil. As they were able to develop their production because of the RWH technologies, they are included in the overall analysis of the impact the installations had on the livelihood of the smallholders.

4. Analysing the Socio-Economic Impact of the Investments

Previous studies on the development of the Alto Jequitinhonha have already shown a considerable change in consumption, life conditions and income diversification (Ribeiro, 2014, p.367). The research conducted with the families indicates interesting trends, which will be discussed in the upcoming section. The tables of the collected data during the conducted interviews with the farmers can be found in the Appendix 3 to 7.

4.1. Productive Indicators

By reducing the fluctuation of the harvesting period and the size of the yield or by improving the quality of the output, the farmer can increase its revenue generated through agriculture and even more importantly improve its resilience due to continuous and nutritious food supply (Adato & Meinzen-Dick, 2002, p.20). The indicators on production aimed at discovering if the investments had an influence on the agricultural activity and its output. The obtained data can be found under Appendix 4. Formerly, the population of the Alto Jequitinhonha had extreme difficulties to produce and harvest during the dry season. The farmers were always keen on diversification but water scarcity led to a limited cultivation of certain products during the dry months. Specially the water-intensive crops, such as banana, mango or oranges (Hoekstra, 2008, p.55), are at least reduced and in many cases even abandoned (Galizoni et al., 2013, p.133).

4.1.1. Size of Plantation

The indicator evaluating the change of the size of the plantation reveals interesting trends. According to the farmers' feedback, a larger plantation can be a product of several factors. *First*, for 50% of the beneficiaries the water harvesting ponds and basins led to an increasing water availability; which in turn enabled them to cultivate and irrigate a larger amount of crops. Most families with a larger plantation tend to invest in water-intensive crops with a significant positive impact on the diet of the household and moreover with a higher financial return when selling the product. *Second*, the increasing size of a plantation can result out of a higher income, which allows investments in production factors. Through the improving availability of the financial asset, the families invest in fences for the vegetable garden in order to protect it, and in irrigation technologies. The fact that a family acquired the adequate

machinery to process the raw material can stimulate a cultivation of a larger area. Through these protective and stimulating measures, families are able to undertake higher investments in its production. As a *third* reason, the specialization in a specific product can lead to a larger plantation. In the case of the municipality of Veredinha two farmers pursue such a strategy, focussing on orange production or processing of sugar cane distillate. Thus, in order to ensure a certain quantity and quality of the good, these families have increased their plantation on the basis of a specific crop or tree.

However, there is a considerable amount of families stating that the size of plantation did not increase and the reasons that were mentioned are manifold. Out of the six families affirming that the installation of the RWH technology did not induce a meaningful change in their livelihood, none of them increased their plantation. Thus, a direct influence of the limited or sometimes non-existent water availability seems to be given. Furthermore, some farmers name serious health issues as a reason for a stagnation of the cultivated area. In many cases, advancement in age is contributing negatively to the agricultural activity. Elderly people have difficulties in maintaining a large plantation and often do not present the need to do so.

The size of the household does have an influence on the increasing size of the plantation. Seventeen families live with their children on the property and almost 60% state that the size of the plantation increased. Out of the thirteen beneficiaries without children in the household only 38% possess a larger plantation then beforehand. Furthermore, it is worth mentioning the difference between the two municipalities of Veredinha and Chapada do Norte. Whereas in Veredinha 62% manage to maintain an increased plantation, in Chapada do Norte almost the same percentage of people affirm that the cultivated area did not increase.

Additionally, half of the interviewed farmers without a larger plantation stated that they managed to produce better quality and more in quantitative terms. This leads to the assumption, that an improvement of water availability does not necessarily induce an increasing size of plantation but leads to a more abundant food production.

4.1.2. Size of the Yield

In general, difficulties were encountered when evaluating the development of the yield. Due to the fact that a quantification of the yield requires a precise and detailed bookkeeping, the obtained results are mainly based on the farmer's individual sensation. In a retrospective analysis of the situation before the intervention, most of the families affirm that their production of alimentation was rather limited and, in most cases, it was not enough for being

self-sufficient throughout the year. Again, the obtained data indicate a more challenging situation in the communities of the municipality of Chapada do Norte. One third of the interviewed families in this municipality state that the yield did not increase, whereas in Veredinha only about 15% does not have a larger agricultural outcome.

In Chapada do Norte, before the construction of the water harvesting pond or basin, ten out of twelve families did not have a production able to feed the family throughout the year. Five beneficiaries could evolve their production over the past one or two years and guarantee food security. Five families are still not able to do so, but two of them observe a positive development compared to the situation before. In the municipality of Veredinha, in turn, the overall conditions are better. When CAV started to attend the communities, four out of eighteen interviewed families were able to produce sufficient food. 60% of the formerly non-self-sufficient beneficiaries managed to become self-sufficient. Only two out of eighteen families are not self-sufficient yet, in one case it is directly linked to the failure of the intervention.

Self-sufficiency through the installation is a very important element in many ways. First, the family is less dependent on food prices, fluctuating according to its availability. Thus, it can be considered a fundamental step to food security and improvement of the families resilience. Thus, an increasing yield leads to a decreasing vulnerability. Besides, the confidence and well-being of a farmer increases when he is able to feed his family.

4.1.3. Diversification and Harvesting

The product diversification and harvesting period are very much interlinked and we therefore analyse the two indicators together. The general scenario pointed out that the families were mainly able to plant and maintain water-intensive crops during the rainy season, lasting from November until March, and during the dry period they were forced to reduce and eventually abandon such cultivations.

Slightly more than half of the farmers observe a more diversified production than before the construction of the RWH technology. In the municipality of Veredinha almost 56% confirm a diversification. In Chapada do Norte in turn only 40% of the farmers managed to diversify. On the one hand the conditions of the soil can have a constraining influence on the successful development of a cultivated crop. On the other hand the time span since the construction of the RWH technology might have an impact on the possibilities of diversification. Until the third year after the construction, the farmers are very often adapting their cultivation and the

mode of production. The families are adjusting the crops according to the experience in the past years. As a consequence, the output tends to vary a little more. Furthermore, the farmers still tend to migrate more until the third year after the intervention and thus less time is invested in planting more laborious crops. The permanence of the male members in the region seems to have an influence on the product diversification and harvesting period.

This is easier to observe when analysing the growing and harvesting period. The formerly four to six months long harvesting period could be extended in all but six cases. Mainly the constructions of 2013 did not improve the time span of harvesting yet. The constructions dating back two years could on average extend the growing and harvesting period by three months. The beneficiaries in 2011 normally harvest about two to three months longer. Farmers, which benefitted of an installation in 2010 can harvest four months longer and the first constructions made in 2009 show an average improvement of the harvesting period of about five to six months.

4.2. Economic Indicators

4.2.1. Agricultural Income

One of the central elements of financial assets is surely the commercialization of the goods. A positive trend can be identified when analyzing the collected data on the generated revenue through agricultural activity. According to the families' declarations, only very few managed to earn money through the cultivation of products before possessing a RWH technology. After the intervention, however, the monetary return from production seems to increase annually. The results of this section are extracted from Appendix 5.

As mentioned above, the results of the collected data suggest that the more time the installation is put in place, the better the output of the production tends to be. As a consequence, in the first year after the construction, the families are rarely able to sell a significant part of their production. Out of the seven visited farmers in the community of Chapada do Norte with a construction built in 2013, only two are able to commercialize their goods and the value does not exceed R\$ 300 per month. Comparing it with the income generated before the intervention, the impact of sales on the raise in salary amounts to an additional R\$ 26 per month per family. This is an equivalent of less than 5% of the total income.

For the interventions made in 2012, and thus year two after the construction, the families seem to have a higher financial return from their productive activity. The amount extracted from the sales of products can reach about a monthly R\$ 600. However, this is still not the rule. Out of seven families only three confirmed to have regular revenue generated through the sales of agricultural products. The raise of the average salary amounts to a monthly R\$ 207 and thus about one quarter of the total income of a family.

The number of regular agricultural income amongst the families receiving an intervention in 2011 is similar to 2012. 50% of the farmers do still not commercialize their products. However, the salary generated can amount up to R\$ 1,400 per month. The average increase in income per family for the constructions built in 2011 compared to the situation before is around a monthly R\$ 350. This composes an approximate 27% of the total financial asset.

A more consistent picture on the financial output from production can be drawn after four years. With the exception of one, all of the benefited farmers dispose a considerable cash inflow ranging from approximately R\$ 200 to R\$ 1,600. On average, this is equivalent to an increase in financial return generated through agricultural production of R\$ 565 per month. With an average total income of R\$ 1577 per month, the amount extracted from agriculture is an equivalent of 36% of the total financial asset.

Surprisingly enough, the constructions dating from five years ago, thus 2009, do not confirm the general trend of increasing income generated through agricultural activity. The three interviewed families manage to generate only between R\$ 100 and R\$ 300 each. A possible explanation is the composition of the sample selected for the year 2009. Two of the three are elderly people and the third family is confronted with serious health issues.

Another interesting observation of the collected data is the fact that the income generated through the agricultural production is the highest when specializing in a specific product. As mentioned before, the two farmers specializing in *cachaça* processing, the sugar cane distillate, and orange plantation are the ones with the highest financial return, earning between R\$ 1,400 and R\$ 1,600. However, it has to be said that both families dispose of a significant additional income through off-farm employment, which makes them less dependent on the agricultural production and thus less vulnerable to shocks. Both families also maintain a small vegetable garden and fruits. The two families (red oval) are standing out in Figure 6 with their additional income compared to Year 0 (Y0).

Note the dispersion of the beneficiaries in Figure 6. In the year 1 (Y1), the year 2 (Y2), the year 3 (Y3) and the year 4 (Y4) after the construction, some farmers are still not able to extract more income from agricultural ativity. In two out of the four cases withouth an improvement of the economic situation in Y3 and Y4 the RWH technology is not retaining sufficient water in order to provoke a change in their production (green oval). Furthermore, one farmer in Y4 already had a significant economic output from agriculture before the intervention and thus did nod observe a change. According to one family, health issues also prevent from generating more income in Y3. The straight line indicates the trend of a linear increase of income generated through agricultural activity.



Figure 6: Increase in agricultural income according to year after construction Source: Household Survey (2014).

4.2.2. Market Participation

The data shows that the monetary profit generated through agricultural production is mainly made by selling locally. In most of the cases the families attend the weekly market in Veredinha, Capelinha or Chapada do Norte. The two communities of Veredinha, and thus beneficiaries of the projects initiated between 2009 and 2012, have a considerably easier access to the market due to better infrastructure, (CAV-) assistance and services of the municipality. The conducted interviews reflect the difficulty of physical capital in the communities of Chapada do Norte. Out of the twelve families visited only one is able to commercialize its products on the local market. It has to be acknowledged though that the market in Chapada do Norte was developing positively by the time this study was written. In the case of Veredinha, the farmers tend to frequent this local sales channel more often. On

average, a farmer sells 2.6 times a month its products at the local market. This figure certainly approves CAV's engagement in the development of local economies through the *feiras livres*, the local markets. Other opportunities to sell the products are local schools or grocery stores. However, in order to be able to do so, farmers have to assure a certain quality standard and produce a considerable quantity. Due to governmental incentives, the remuneration is by trend higher when selling to the local than the average price payed at the grocery stores or at the local markets. Only one family with a specialization in a product pursues this strategy.

4.2.3. Other Sources of Income

In the Alto Jequitinhonha the financial revenue from agricultural production is not the only important factor for the composition of total revenue of a family. A series of interesting observations can be made in respect to the livelihood strategy. The figures show that no family can survive and generate sufficient cash from agricultural activities alone and therefore renounce to other sources of income. Two important components have to be emphasized.

4.2.3.1. Off-farm Employment

First, by trend, the younger generation, considering people younger than fifty, depends on an off-farm employment. Out of the fifteen families of this age group only 20% do not migrate or have an additional and sometimes informal job in town. The off-farm activities amount from a monthly R\$ 270 for unqualified workforces and day labourers up to R\$ 1,300 in the seasonal migration for hard physical workload. As the plantations require a permanence of four to seven months, the maximum wage per annum amounts to R\$ 9,100, which results in an equivalent of R\$ 760 per month. The population below fifty of Chapada do Norte generally still migrates, with an exception of two interviewed families. It has to be taken into account, though, that no intervention in Morro Branco and Cuba dates back more than two years. It is probable that in the future improved water availability encourages the farmers from these two communities to stay throughout the year in the Alto Jequitinhonha. The people interviewed above the age of fifty in the municipality of Chapada do Norte have all worked on plantations during the seasons for 22 up to 38 years and can therefore also live on the savings accumulated over the past decades and their retirement pensions.

The division between the two municipalities with regard to additional occupation is apparent. Whereas in Veredinha approximately 40% of the families depend on an off-farm employment, almost 60% of the population of Chapada do Norte pursue an economic activity besides agriculture. The average salary earned through the off-farm activities plays a more important role in the income composition in the communities of Chapada do Norte compared to Veredinha. This is mainly due to the higher revenue generated through migration and the permanent absence during four to seven months. The average revenue of the seven families of Chapada do Norte with an additional work amounts to a monthly R\$ 830. In Veredinha the seven families have an average income generated through the off-farm employment of R\$ 600 per month. Given this result, we can make the assumption that in an initial phase after the construction of a RWH technology, the composition of the financial asset of the family is more dependent on the off-farm activity of its family members.

4.2.3.2. Public Policies

Moreover, in terms of financial assets, the public policies mentioned under chapter 2.2.1. form an important component of the livelihood strategy of the population in the Alto Jequitinhonha. In both municipalities the significance of such cash transfer policies for the families is similar. Out of the thirty families interviewed, only three do not obtain governmental support in form of cash transfer. The amount of the financial support varies according to the size of the family and the age of the person. The *bolsa famila* tends to bring in about R\$ 50 per child. All interviewed families having children under the age of eighteen obtain the benefit.

The pension and the incapacity compensation amounts to a minimum wage. Slightly more than 50% of the population in Chapada do Norte as well as Veredinha receive R\$ 720 in form of a retirement pension or incapacity benefit. This normally composes at least 50% of the financial assets of the livelihood strategy of elderly or invalid people. In Tupy & Toyoshima's work (2013, p.1) this trend is also mentioned, revealing that the social assistance in the whole Vale do Jequitinhonha amounts to almost 30% of the municipalities' GDP. As Figure 7 on the revenue composition indicates, cash transfer policies are able to reduce poverty and inequality. However, the missing counterpart leads to a certain passivity and does not stimulate the agricultural production (Souza de Almeida & Souza, 2014; Tupy & Toyoshima, 2013, p.6).

The financial assets of the livelihood strategy can be visualized very clearly according to age and municipality. Figure 7 divides the two age groups; from thirty to fifty years old, and above fifty years of age, in the two municipalities Veredinha and Chapada do Norte. Thereby each quarter, with the average total income in the left upper corner, is divided into the sources of income. The figure reveals that the total salary does not vary significantly between the different age groups or municipalities but its composition does.



Figure 7: Income composition divided into age groups and municipalities Source: Household Surveys (2014).

Whereas agriculture forms an important part of the income composition amongst both age groups of Veredinha, the commercialization of the production in Chapada do Norte tends to be very low. Social policies are much more important for older people than for the population under fifty. As a consequence, many young people are obliged to pursue an off-farm activity.

4.2.4. Consumption, Exchanges and Donation

The financial income generated through agriculture is a positive consequence of an increasing production. This generally induces that the farmers have enough products for their household consumption. According to CAV's survey on household expenditure and to statemets of the families, the consumption of one person amounts approximately to R\$ 60 per month. A study conducted in 2010 revealed, that in the Vale do Jequitinhonha the consumption per family of the proper production amounts to 26 to 40% of a minimum wage and thus around R\$ 200 to R\$ 300 (Ribeiro, 2014, p.372). The monetary value of such self-sufficiency has to be taken into account when evaluating the financial asset of the families in the Alto Jequitinhonha and the positive impact it has on the resilience mentioned under chapter 4.1.2. is highly significant for the individuals of the region.

Exchanging agricultural products is part of the economic cycle of the communities. Very often the farmers trade locally amongst themselves in order to complement the diet of the household. According to the same study of Ribeiro et al. (2014, p.374) this complementation through exchanged goods is not a major part of the consumption in the Vale do Jequitinhonha. However, 22 interviewed families interact with other farmers in their community exchanging their production. Besides the monetary value of the exchanges, the products contribute to an improvement of the social asset. The communitarian tie between its members is strengthened through the interaction. In some cases families advance or donate products to more needy people of a community. Half of the farmers in their sinterviewed state that they donate part of their production to other families, for charity or for events in the region.

4.2.5. Investments and Expenditure

Ribeiro et al. (2014, p.378) evaluate the improvement of the purchasing power of the families of the Alto Jequitinhonha between the years 2000 and 2010. The analysis of the collected data confirms this trend. Almost 90% of the farmers invested in their production, in the property or acquired consumer goods. Given the diverse sources of income, it is difficult to determine if the used financial resources are a result of the RWH technologies.

Two out of three farmers state that an investment in the production factors was made since the installation of the RWH technology. The production and processing of agricultural goods is facilitated through the possibility of using machines instead of manual labour. Hence many families invested in buying little motors in order to process sugar cane or to grind the food for livestock. The governmental programme PRONAF acts as a facilitator of such purchases. Slightly more than a quarter of the beneficiaries state that they made use of the credit. The main investments through the credit are made in little motors or fencing off livestock and cultivation. Five families invested in additional RWH technologies, mainly ponds or cisterns for storage.

Furthermore, 70% of the farmers invested in their property. The money is mainly directed to the renovation or construction of the kitchen, building new toilets or painting the residence. As part of the property, the families also invested in consumer goods. Electric power stimulated the acquisition of several goods such as telephones, fridges, washing machines, televisions or even computers with Internet access. Only three families, all home to the municipality of Veredinha, do not have access to electricity yet. Hence, it is not surprising, that the percentage of families with expenditure in consumer goods is higher in the

municipality of Chapada do Norte. 40% made such an expenditure compared to 27% in the municipality of Veredinha. Furthermore, electric power contributes to the development of human capital. Children are able to study at night and families have access to information. As a consequence, the quality of life improves considerably and creates new opportunities.

Even though the output of the agricultural production did increase for farmers, this does not mean that their total cash inflow increased. What certainly changed for the families with an intervention lasting more than two years is the way they obtain their capital. For the rural population it is a blessing to stay in the field instead of travelling to distant plantations and execute hard physical work (Souza de Almeida & Souza, 2014). Thus, the increase of the financial output from agricultural activity is a privilege for the families of the Alto Jequitinhonha. As the analysis shows, it can be assumed that it is strongly interlinked to the improvement of availability of natural assets, mainly water.

4.3. Social Indicators

The social and communitarian structure in the rural area of the Alto Jequitinhonha is very much influenced by the seasonal migration. The permanence of men and women in the field and thus the composition of inhabitants present in the rural area is affected by the choice of livelihood strategy.

4.3.1. Seasonal Migration and Permanence in the Field

During the migration season, villages are predominantly home to women while male family members are working on the plantations. With the turn of the century, most families in the community of Veredinha stopped migraty. Only three households did and one, currently in Y2 after construction, still does. In this specific case, the construction of the RWH pond allowed the family to extract a higher revenue from agricultural production and, as a consequence, they managed to reduce the seasonal migration from seven to four months. In some cases of more recent constructions in the municipality of Chapada do Norte, it is possible to observe that some families already tend to reduce the migrational period. The first families in working age stopped migrating two years after the intervention. In these cases the interviewed farmers stated the positive influence of water availability on the permanence in the field. Galizoni (2000, p.7) affirms, that the halt of the seasonal migration can, amongst other things, be attributed to the availability of water.

In general, the permanence in the field tends to improve due to the better availability of water. As a consequence of water scarcity the families had to walk to the nearest water source in the region, which could be from a few hundred meters to five kilometres away. Thus, in worst case, the family invested up to five hours looking for water per day. Both genders are equally dependent on the availability of the natural asset for their activities in the rural area. Women are mainly responsible for the irrigation of the vegetable garden, the washing of clothes, taking care of the household, including the cooking and the children. Men are traditionally taking care of livestock and engage in more physical labour. The harvesting of sugar cane or having forms part of the main male activity in the agricultural production. With the implementation of the RWH technologies, thirteen out of 27 women and eleven out of 26 men affirmed that they are able to save time. Eighteen beneficiaries out of the thirty note the direct influence of the water availability on the daily routine. In the case of installations built in 2009 or 2010, all families are able to spend more time in the field as a consequence of improved water availability. For the constructions made after 2010, eleven of the twenty families affirm that their time in the field did not increase. It has to be mentioned, that in some cases the families assisted by the project in 2011 already had satisfactory access to water and thus do not notice an improvement. In the municipality of Chapada do Norte three families state that the intervention did not have an impact on water availability at all and, consequently, their daily routine still includes the time looking for water.

4.3.2. Individual Sensation of Water Availability

A similar picture is drawn by the individual sensation of water availability. Almost three quarters of the families affirm that the availability has improved with the intervention of CAV. In cases where the RWH technologies did not have the expected effect, families still suffer from water scarcity. Formerly, eighteen households were dependent on the service of water trucks provided by the municipality. And even more necessity existed. Most families would have liked to utilize this offer but in six cases the remoteness or difficulty of access did not allow the truck to get to the property. Furthermore, due to large waiting lists for the water truck the productive activity was extremely unpredictable for farmers. Thus, the availability of the natural asset does not only improve the permanence in the field, it also reduces the sensation of vulnerability and enables the farmer to act more independently. According to farmers, the quality of the water delivered by the truck is unsatisfactory. Through the revitalization of some streams and the protection of the precious springs, CAV's

interventions led two thirds of the interviewed families to state that the water quality improved.

4.3.3 Location of Children

One of CAV's assigned priorities is to tackle the rural exodus. Not only for the organization but also for the government, this social trend is very preoccupying and challenging. The results of the data collected and the perception of the preferences of young people growing up in the rural area of the Vale do Jequitinhonha is not very encouraging. Nineteen families have children under the age of 25 and there is a certain trend observable. When young people are in between eighteen and 22 years of age, many of them tend to leave the rural area. Of all twelve families with children between twenty and twentyfive, only three of the children in this age group are in the rural area. For most of the young people the plan is to move towards a city in a closer (Veredinha, Turmalina) or more distant region (Diamantina). Only very few consider working in the rural area as an attractive option. According to the study of Mendoça (2013, p.460), just 27% of the region's young adults stay in the rural area and are able to transfer their acquired knowledge to others. Thus, the rural exodus will remain a relevant topic for the following years. CAV's agricultural school EFAV is an instrument to motivate young people to stay in the Alto Jequitinhonha.

Six interviewed families send or have sent their children to school in order to develop human capital linked to regional peculiarities and agricultural traditions. Nevertheless, three important hurdles exist in order to incentivize young people to stay. According to the interview with key informants, the difficulty of obtaining financing to buy land is certainly a constraint for young people (Souza de Almeida & Souza, 2014). Furthermore, many young community members state that labour in agriculture is tough and they prefer to earn money in the villages nearby. Additionally, infrastructure development, easy access to communication and professional opportunities seem to attract the younger population, elements not available in the rural area. This might also be a consequence of better access to education and the development of human capital in the region. A large part of young people has the possibility to go to school up to the secondary level. All of the twenty families with children in the age of the secondary level or higher have sent them to school. Thus, the opportunities are automatically better than twenty years ago when the government did not invest considerably in educating the population of remote areas.

4.3.4. Participation in Community Assistance

CAV also aims at strengthening the human asset in the communities. The beneficiary of a RWH technology commits himself to participating in trainings and courses developing the human assets related to the installation as well as to specific topics dealing with agricultural production. All farmers state that they participated in such courses. Thus, the capacitation of families can be considered at least sufficient in all four communities. The transfer of basic knowledge through the NGO is an important element in order to develop a consciousness as well as to facilitate the self-maintenance of the installation and the assumption of responsibility over the production. Further capacitation is executed through the technicians' visits to the families. According to the key informant interview with the technicians, the visits decline gradually over time, whereby the presence of the CAV employee is particularly important in the first two years (Souza de Almeida & Souza, 2014). Normally the technicians try to visit a family twice a year in an initial phase. As a consequence of improving knowhow and farmers' independence, after the third year of the construction the presence tends to decrease. According to statements of the technicians, the reduction of mentoring of a community presents a challenge to CAV (Souza de Almeida & Souza, 2014). The families enjoyed a very personal assistance over a few years, the NGO encourages them to optimize their production and tries to make it more sustainable. Without this support in elaboration and execution of a productive strategy, some families are struggling to maintain the level achieved during the monitoring. The technical assistance provided through courses and visits on the properties certainly contributes to an improvement of the human capital. By learning how to produce as well as to process more effectively and healthier, the farmers acquire know-how ensuring a more sustainable development. However, the challenge is to encourage the farmers to keep up with the methods ensuring quantity and quality of their production.

4.4. Communitarian Indicators

The objective of analysing communitarian indicators is to verify if the communities are committed to the development of the social assets encouraged through CAV in order to strengthen their position. The organization tries to engage the families actively in the organization of the rural communities. Normally the NGO aims at handing over certain responsibilities and tasks to the local population in order to develop the human and social capital.

4.4.1. Leadership, Location Committee and Spring Protection Couple

When entering a community, CAV selects a family with a certain importance and a good reputation in the village as contact and reference for further activity. The chosen family exerts a leadership function and establishes the dialogue between CAV and the community. The community leaders of Morro Branco and Cuba are younger than fifty. Both of them occupy the role of forerunners as they are trying not to migrate anymore and serve as role model by increasing their permanence in the respective community. CAV engages the two community leaders to a maximum possible. One of them participates in the pilot project on bookkeeping.

Even though the leaders exert a particularly important function, when taking decisions the whole community is assembled and statements of the members are taken into account. In this way CAV manages to empower the individuals and the community as a whole. The organization encourages the dialogue and the ultimate decision where to construct the RWH technologies is made by the community. Thus, CAV seeks to satisfy the demand of the community as a whole with its interventions. A *location committee* is elected by the community members in order to accompaign the constructions. Furthermore, once the RWH technologies are put in place, a *spring protection couple* is elected. One of the families interviewed does exert this function.

4.4.2. Participation in Community Meetings

This evidently requires an active participation of the community members in the regular meetings. Indeed, twenty out of the thirty families state that they actively participate in the communitarian life. The location has a noticeable impact on the participation of the population. Whereas in the communities Monte Alegre and Gamileira only 22% do not participate actively in the community associations, the municipality of Chapada do Norte shows a more divided picture. Half of the population affirms that they do not participate actively in the associations. There are certain explanations for the phenomenon. During the migration season, many women are alone at home taking care of children and property. Due to an overload of work, it turns out to be difficult to attend the community meetings. According to the key informant interview with technicians, the absence of a considerable part of the population during the migrational period is a main challenge when dealing with the communities of Chapada do Norte (Souza de Almeida & Souza, 2014). Furthermore, the

activities of CAV in the communities is relatively recent. It might be a matter of time until the families engage more actively in Morro Branco and Cuba.

Moreover, age has an influence on active participation in community organizations. The obtained data indicates, that people under fifty tend to participate more in the communitarian life. Almost three quarters of this age group does attend the regular meetings and thus contribute actively to the decisions. Elderly people in turn tend to have a lower degree of participation in the communitarian activities. Only 56% state that they attend the meetings. Mainly two factors seem to lead to a lower participation of the older part of the population. *First*, a displacement to the meeting venue is needed. Elderly people often do not have access to transportation or are not able to cope with the strains caused by the dislocation. Thus, a participation turns out to be a logistics and health related challenge. *Second*, older people name their contribution in an earlier stage and the necessity of engagement of the younger generation. Furthermore, according to some older beneficiaries, young people have the ability to read and write, which facilitates many tasks.

4.4.3. Participation Market Association and Women Organization

Another indicator used for evaluating the communitarian participation is the engagement and membership in the market association. As elaborated in the economic analysis, in the community of Veredinha the structurating of the market has contributed significantly to a diversification of sales channels for the farmers. The impact of such an association can also strengthen the social assets. Through an engagement in such an organization, the smallholder can develop a stronger social network, count on support of other members and thus becomes less vulnerable. Such participation also helps to evolve human assets if incorporating a leadership role or when holding a position as treasurer, for instance. Hereby it has to be mentioned that a membership and participation in the association makes particularly sense when disposing of a production with the capacity to sell a part of it. Furthermore, CAV and the local government are currently structuring the market in Chapada do Norte and thus the same degree of engagement cannot be expected yet. The lower degree of participation of the people from Chapada do Norte can be a result of the communities' limited production.

When participating of the market association, the farmer agrees to contribute to the fund enabling loans for future investments of the community and for reparation on already existing RWH methods. The starched social structure and communitarian collaboration thus enables the use of the fund for collective purchases. Hence the fact of accessing the fund for loans is a sign of intact communitarian functioning. Specially the communities of Veredinha are making use use of it, whereby the figures are similar to the participation of the market association. Whereas in Veredinha about two thirds are benefiting from the purchases, only 15% of Chapada do Norte are making use of it. However, the explanatory power of the indicator for communitarian solidarity has to be relativized. One has to be conscious that the fund enables mainly the acquisition of production factors. Thus, if a farmer has a limited output of its plantation it might not be worth for him taking a loan.

Furthermore, the interviewed female community members were asked about their participation in the women's group supported by CAV and financed through VM. Mainly the communities of Morro Branco and Cuba are targeted by the programme launched in 2012 (*Female Smallholders and Income Security*). However, five out of the eight interviewed women in the communities had never participated in any activity of the group. In the communities of Gamileira and Monte Alegre the women are more conscious about it but attendance to events is rather rare. None of female members of the interviewed families occupies a leadership position on this topic. Again, the intensive engagement during the migrational period limits the women's possibilities to participate in the activities.

5. Discussion

5.1. Changes in Livelihood Strategy and Outcome

The obtained results of the interviews allow a discussion on the relevant findings of this study. The objective of the investments of VM in the RWH technologies is to shape positively the development of the livelihood strategies and outcomes. Through the evaluation of data, beneficiaries can acknowledge a positive trend of their well-being after the installation of the ponds and basins. As shown previously, the time factor plays an important role on the impact of the installation on the livelihood of people. The following Figure 8 visualizes the effects the RWH technology has on the farmer's access to assets and illustrates the socio-economic development over time.

- Y 1: Construction
- Diversification of
- production

 Rarely enough
- production for
- consumptionDependent on
- migration/other sources of revenue
- Strong CAV presence
- Y 2: Adaptation • Production adapted according to experience
- in y1Production for
- Consumption
 Migration very common
- Strong CAV presence
- Y 3: Intensification • Maximizing production and diversification
- Commercialization of products
 Increasing permanence
 - Increasing permanence in the field and reducing migration
 Significant CAV
 - Significant CAV
 presence
- Y 4: Maintenance • Maintenance and optimization of
- productionDiversification of sales channels and
- processing if possibleNo more seasonal migration
- Reducing CAV
 precence
- Y 5: Independence
- Tentative of independent maintenance of production
- Maintenance of sales channels
- No more seasonal migration
- CAV presnece minimized

Figure 8: Socio-economic development of beneficiary on a time axis

By trend, during the first year, no remarkable changes can be observed. Farmers tend to use the initial months to gain experience and to facilitate the access to water. The production cannot be increased considerably as the farmer is testing and trying to maximize the impact of the RWH technology. However, also upon recommendation of CAV, many farmers try to diversify their production. The access to financial assets does not improve significantly. Even though the farmer has the possibility to access credits like PRONAF or the communitarian fund, loans are rarely taken up in an initial stage. Income generated through agriculture is normally unimportant in comparison to the monetary inflow of cash transfer policies or offfarm employments. Given the relevance of these additional jobs, the impact on the social structure tends to be very low. People continue migrating or are dependent on an employment in the cities. Hence the productive activity on the field is mainly carried out by the female members of the community, as they are predominating in the rural area. Understandably, priority is given to the maintenance of the basic production and the care of children, having a negative effect on the participation in the communitarian meetings. However, as the social cohesion in the Alto Jequitinhonha is in an advanced stage, the families can count on the support of other members if needed.

After the second rainfall some basic changes can be observed. In general, the second year can be characterized as year of adaptation. The farmer makes a first analysis of the impact of the technology on the water household and its consequences on production. The results of the previous experience build the cornerstone of a more promising second year. Hence the production is complemented with new crops. Other products, not successful in the first year, are sometimes abandoned. The outcome of agricultural activity tends to be higher in the second year and self-sufficiency is more a rule than an exception. However, the commercialization of the products is difficult. Nevertheless, the monetary output generated through agriculture forms a more important part of the financial asset composition. As a consequence, other sources of income generated through additional employment normally play a decreasing role. However, migration is not abandoned. In a few cases, men change the type of migrational work from sugar cane harvest to coffee picking and reduce the period of absence from seven to four months. Thus, the composition of the community starts to change slightly and both men as well as women can dedicate more time to agricultural activities. Nevertheless, it seems that the additional time at the farmer's disposal is not spent in community engagement.

The third year after the intervention, families already dispose of valuable experiences from previous years. The farmer is normally able to assess the impact of the RWH technology on the water household and the production. Thus, the cultivation of certain crops is done with more confidence and with a more precise expectation pertaining to the outcome. The third year can be characterized as a period of intensification in terms of production. If the pond or basin retains and infiltrates water, the family normally manages to be self-sufficient throughout the year. Water availability allows a diverse and abundant production. The

exceeding production is sold in the local markets. The families tend to frequent the market approximately 1.3 times a month. This leads to an increase in revenue extracted from agricultural activity. Off-farm employments and public policies remain a very important factor of the financial assets available. Nevertheless, according to the interviewed farmers in the third year, seasonal migration does not form part of the livelihood strategy anymore. The whole sample is home to Veredinha and only one farmer migrated before. Due to the dependence on migration in the case of Chapada do Norte, it is likely, that some families will still be migrating in the third year. In Veredinha the communities are composed of male and female members throughout the year and the permanence in the field is higher than in previous years. The participation of communitarian meetings tends to improve. Through the development of the market association and human as well as social asset, the members tend to coordinate their productive and economic activities better.

Four years after the establishment of the RWH pond or basin the farmer enters the phase where the quantity and quality of production of the previous year should at least be maintained. The product diversification is generally not expanded anymore. Some families start investing in products processing in order to create an added value. Through the production of sugar cane distillate, caramel or ricotta-like cheese the income can be additionally increased. Agriculture can amount up to 50% of the family's income, in particular when specializing in a specific product. On average, the beneficiary's sales of the production is an equivalent of 36% of the financial asset. The attendance to the weekly market is higher than in the years before; on average, every farmer frequents it 3.4 times per month. The community members normally participate actively in the association. Four years after construction farmers tend to engage themselves more intensely in the community association and incorporate leadership functions. Furthermore, it is common that the benefited people are interested in transferring knowledge to other community members or to young people.

Due to the unfavourable choice of the sample, the analysis of the fifth year after the intervention poses some challenges. However, some general trends can be deduced from the obtained data. Even families with a limited capacity to produce are able to remain in the rural area. Evidently, survival is amongst other things dependent on the income generated through cash transfer. Nevertheless, the farmer produces sufficient for the household consumption and disposes, according to the interviews, of an improved life quality. The beneficiaries of this year are good samples to illustrate the importance of existing social capital. Even though

passing through difficulties, farmers can rely on the support of other community members. The ties in the community seem to be sufficiently strong allowing a decreasing presence of CAV in the community. As a consequence, the farmer is confronted directly with the assumption of responsibilities in associations and other organizations, developing the human and social capital further. Nevertheless, one has to be conscious, that aging of the rural population and health issues can provoke new challenges to an engagement in the Alto Jequitinhonha.

5.2. Economic Viability

According to the obtained results on the change of access to the five essential assets and the implications on the livelihood strategy of people, it can be claimed that the RWH technologies have a positive impact on the livelihood outcome of the rural population of the Alto Jequitinhonha. The traditional economic payback approach serves as an important complementary method to evaluate the impact from an economic perspective and to respond to the second research question.

The calculation aims at defining how long the beneficiaries would have to invest their additional net revenue earned through agricultural production once the installation is put in place. Hereby it has to be mentioned, that very often the farmers renounce to additional sources income in order to improve the production. This opportunity cost (OC) has not been taken into consideration in this calculation, because many important external variables (leisure, home time, etc.) were not available and the cost-benefit analysis is strongly influenced by the way labour is valued (Fox et al., 2005, p.235; Huffmann, 1996, p.15-17).

5.2.1. Economic Payback Calculation

As a consequence, the economic payback calculation aims only at providing a figure on how much more money is generated in the region through agricultural production after the construction of RWH technologies. The formula for the payback calculation is as it follows:

$$Payback Period = \frac{Initial Investment}{Periodic Cash Flow}$$
(1)

As Table 2 under chapter 3.2. shows, the total initial investment of VM in RWH technologies amounts to CHF 613'774. As we do not dispose of beneficiaries of the year 2008, when the first transfer of CHF 13'845 was made, the amount is ignored for the calculation. Thus, the initial investment to be considered is CHF 599'929. In order to define the periodic cash flow generated through the farmers, the extracted salaries mentioned under chapter 4.2. are used.

5.2.1.1. Average Gross Farm Revenue and Average Net Farm Revenue

This requires the average gross farm revenue of each year compared to the average revenue before the intervention (Y0). The figures of revenue per year are extracted from the monthly earnings of the families nowadays in the respective project phase. As elaborated in chapter 4.2., the income through agricultural activity tends to increase every year after the construction. The average increase of gross farm revenue is given by

Average Increase Revenue
$$_{Y0 \text{ of group}}(AIR) = \frac{\text{Total Revenue of Group in 2014} - \text{Total Revenue of Group in Y0}}{\text{Number of Beneficiaries of Group}}$$
(2)

The individual salaries of the beneficiaries of a certain year can be found from Table 10. As an illustration, the calculation of the average gross farm revenue per month of the families with an intervention dating from 2009 is calculated as it follows:

$$AIR_{2009} = \frac{(R\$ \ 300 - R\$0) + (R\$ \ 150 - R\$ \ 0) + (R\$ \ 150 - R\$ \ 0)}{3} = R\$ \ 200$$

In Year 1 after the installation of the RWH technology the additional average revenue amounts to R\$ 312 (see Table 4). In Year 2, the additional revenue generated through agriculture is R\$ 2'314. In a third year the families normally earn an additional R\$ 4'200 and in the fourth year R\$ 6'771. Only after five years the farmer gains a lower income than the year before with an increase of an annual R\$ 2'400 compared to Y0.

For our calculation, however, the net farm revenue from agricultural activity is needed. Due to a lack of data on the individual expenditure, it is difficult to identify a clear trend. Only the institutionalization of the market trade association in Veredinha and the collective purchases provide figures on individual expenditure for organic fertilizers. In the community of Veredinha the families spent in 2014 on average R\$ 350 in such products (see Appendix 8). Table 13 includes the figures of the spending in organic fertilizers of the visited families. The average spending of a beneficiary in S1 amounts to approximately R\$ 215 (obs.: S1 is the season after the construction, due to the necessity to buy it beforehand). In the second year this value tends to be slightly lower, around R\$ 195. In the third year, however, the

expenditure for fertilizers is increasing again, amounting to R\$ 360 per annum. Given the figures from Veredinha in 2014, we can assume that the amount spent for organic fertilizers after Y3 tends to be around R\$ 350 as well. The additional spending for seeds is estimated on the basis of the size of the plantations. In the first two years the cost of the plantation is lower, due to the lower amount of seeds needed. For S1 the price of R\$ 30 is defined and for S2 R\$ 60. Three and more years after the construction, the costs amount to approximately 100 R\$ (Fernandes et al., 2007, p.21; Portal Hidroponia, 2014). Due to their uniqueness and high costs, the investments made in machines enabling the processing of goods are not considered. Substracting the total expenditure from the average increase per annum, the following net incomes are obtained:

Year of Construction	Average Increase (Month)	Average Increase (Annum)	Expenditure	Net Income
2013 (Y1)	R\$ 26	R\$ 312	R\$ 245	R\$ 67
2012 (Y2)	R\$ 192	R\$ 2'314	R\$ 255	R\$ 2'059
2011 (Y3)	R\$ 350	R\$ 4'200	R\$ 440	R\$ 3'760
2010 (Y4)	R\$ 565	R\$ 6'771	R\$ 450	R\$ 6'321
2009 (Y5)	R\$ 200	R\$ 2'400	R\$ 450	R\$ 1'950

Table 4: Additional average net revenue according to year of construction

5.2.1.2. Additional Net Revenue Adapted to Inflation and Exchange Rate

Inflation rate in Brazil poses a challenge to the elaboration of a meaningful evaluation of the payback evaluation. The salaries earned in 2014 were certainly lower a few years ago. Thus, the actual salary has to be adapted to the respective years.

The vertical axis of Table 5 stands for the year of the construction and the horizontal axis for the average net income of the individual in the group of beneficiaries the respective year. The annual salaries of Table 4 are used for Table 5 and adapted according to the inflation (annual inflation can be extracted from Appendix 9). As an illustrative example, in 2014 a family with an installation dating from 2011 is considered to be in Year 3 (Y3) and thus with a net earning of R\$ 3'800 a year. The beneficiaries of 2010 were in their third year in 2013. The inflation between 2013 and 2014 was 6.5%. As in Brazil the salaries are by trend accompaigning inflation, the annual salary of the beneficiary of 2010 in Y3 was 6.5% lower than the one of 2011 in Y3. The average annual inflation between 2010 and 2014 amounted

to 6%. This percentage serves for the projection of the inflation of the following years, marked by a "*".

	Y1	Y2	Y3	Y4	Y5
2009	53	1'725	3'356	5'969	1'950
2010	56	1'837	3'551	6'321	2'067*
2011	60	1'944	3'760	6'700*	2'191*
2012	63	2'059	3'986*	7'102*	2'322*
2013	67	2'183*	4'225*	7'528*	2'462*

Table 5: Annual average agricultural net income according to year of construction in R^{\$} considering inflation

* Estimated calculation on the basis of average inflation (2009-2013) = 6% annually (source: Brasilian Central Bank, 2014)

The investment data from VM in Table 2 are listed in CHF, whereas the collected information on revenues are in R\$. For the calculation of the duration of the amortization, the increase of average income is converted from R\$ into CHF. The CHF-R\$-exchange rate can be found in Appendix 10, which is used to calculate the salary in CHF. Figures marked by a "*" are calculated with a projected exchange rate of the CHF-R\$. Analyzing the CHF-R\$ exchange rate between 2010 and 2014, the Brazilian currency devaluated an average of 9.6% per year.

	Y1	Y2	¥3	Y4	¥5
2009	32	1'015	1'766	2'985	780
2010	33	967	1'776	2'528	754*
2011	32	972	1'504	2'445*	730*
2012	32	824	1'455*	2'367*	706*
2013	27	797*	1'408*	2'288*	684*

Table 6: Net average agricultural income per annum in CHF considering CHF-R\$ exchange rate

* Estimated calculation on the basis of average CHF-R\$ exchange rate development (2009-2014)

5.2.1.3. Economic Payback Period

In order to analyse the economic payback we calculate for every year VM invested the time span needed for the number beneficiaries to pay back the investment made by VM. As elucidated under 3.2., the investments include contributions in the planning, the construction

and maintenance of the water harvesting ponds and basins. Furthermore, the money covers the project management in Brazil as well as in Switzerland, the operational costs, the technicians with their consulting function and the communitarian work for productive questions. As an illustration, the example of payback calculation for the investments made in 2009:

Table 7: Payback calculation for investments made in 2009

Total Invested Amount = CHF 62'517

Annual Individual Income (of agriculture in the year)	Beneficiaries (in 2009)	Total Income Generated (by all farmers)	Value still to be amortized
2010 (y1) = CHF 32	*17	CHF 544	CHF 61'973
2011 (y2)= CHF 1'015	*17	CHF 17'225	CHF 44'748
2012 (y3) = CHF 1'766	*17	CHF 30'022	CHF 14'726
2013 (y4) = CHF 2'985	*17	CHF 50'745	-
2014 (y5) = CHF 780	*17	CHF 13'260	

The calculation indicate that the benefited farmers of VM investments for the year 2009 would be able to reimburse the installation with its additional revenue in 3.29 years. The whole calculation of the formula has to be repeated for every year taking into account the changes of the Average Individual Revenue due to the varying exchange rates. The detailed results can be found in Appendix 11.

On the basis of these figures and the number of beneficiaries, the time can be calculated on how long the farmers would have to contribute with their additional salary in order to pay back the investments of their respective year. The results obtained are as it follows:

2009 = 3.29 $2010^{1} = 5.21$ 2011 = 3.11 $2012^{2} = 6.59$ 2013 = 3.12

¹ For the 2010 the beneficiaries are not able to return the investment within the five years. The salary of the sixth and seventh year were defined as an average revenue of the Year 1 to Year 5, amounting to CHF 1'212 per year. ² For the 2012 the beneficiaries are not able to return the investment within the five years. The salaries of the sixth and

² For the 2012 the beneficiaries are not able to return the investment within the five years. The salaries of the sixth and seventh year were defined as an average revenue of the Year 1 to Year 5, amounting to CHF 1'077 per year.

The results of the economic payback calculation are dependant on how many farmers benefited from the granted money each year. In 2011, 53 families received an intervention. As a consequence, the time the families would need to reimburse the amount conceded is considerably shorter than for the nineteen families in 2012. Taking the mean of the five years VM has invested in RWH technologies in the Alto Jequitinhonha, the 151 beneficiaries would need to invest their additionally generated net income from agricultural activity over 4.26 years or four years and three months.

Given this number, from an economic payback analysis, the RWH methods can be considered to be cost-effective and viable technologies. Furthermore, the water harvesting ponds and basins enable farmers to generate a considerable economic output through agricultural production. Families are able to save the cost of purchasing water, a good that is always becoming ever more scarce and expensive.

6. Conclusion

Throughout this study, the impact of RWH methods on the livelihood of people home to the Alto Jequitinhonha was elaborated. The unfavourable initial conditions the region's population is exposed to and the farmers' vulnerability are tackled by the local organization CAV with financial support of the Swiss foundation VM. Since 2008, VM has invested in RWH technologies, namely ponds, smaller basins and diques. Through such interventions, the NGO aims at influencing positively the livelihood strategy and outcomes of the population of the valley. Thus, the purpose of this study was to evaluate the impact such interventions have on the strategy. In order to respond to the research question "how does the implementation of RWH technologies affect the livelihood of the population of the Alto Jequitinhonha and what is its economic payback, the study evaluated 23 indicators aiming at explaining the productive, economic, social and communitarian development of the region according to the access to the five different assets.

As shown, the livelihood outcome is positively affected by the interventions built through CAV. Income forms part of the criterion analysing the outcome of a livelihood. According to the obtained data, the total income of the families does not necessarily change significantly but the growing importance of the output deriving from agricultural production in the composition of the financial asset can be evaluated as a positive trend for the region. Hence the income generated in the Alto Jequitinhonha does increase over time. Besides the monetary return of agriculture, self-sufficiency can be considered an important element for food security and thus reduces the farmers' vulnerability to shocks, trends and seasonalities. When analysing the composition of the financial resources one has to acknowledge the importance of governmental policies. The cash transfer programmes and the governmental credit lines contribute to the improving possibilities of farmers of the Alto Jequitinhonha. Enabling the families to stay more permanently in the region is a way to further strengthen the communitarian and thus social ties. A reduction of migration and easier access to the physical and natural asset water implies an increase in well-being and quality of life. Strains and physical work load on plantations is reduced through the implementation of RWH technologies. CAV's activities aim at empowering the male and female smallholders and at a more conscious use of natural assets. The ability to adapt the production and livelihood to the regional peculiarities is a notable strength of the organization. Capacitation and education are two core elements to develop the human capital in the region. Courses, trainings and an agricultural school are appropriate means to do so, but require persistence and publicity in order to improve the participation of population and commitment.

With the RWH technology at the core of its strategy, CAV's engagement promotes the access to the five assets. The farmers' vulnerability is strongly influenced by water availability. Through the implementation of ponds and basins, the NGO successfully tackles the problem of water scarcity and thus manages to reduce the farmers' vulnerability. Furthermore, the calculation of the return on investment revealed that the RWH technologies can be considered a cost-effective method to fight poverty in the rural area of Minas Gerais. In order to cover the costs of the project, a farmer would have to pay back its additional net salaries generated through agriculture over four years and three months. Bearing this in mind, the impact and importance of the investments of the Swiss foundation VM have to be highlighted. For the smallholders of the region an investment over four years would imply a significant financial risk and thus affect their vulnerability. The financial contribution of the farmers and successfully fights poverty in the Alto Jequitinhonha.

7. Literature

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8. Annex

Appendix 1: Indicators

Production indicators

- 1. Size of plantation; are the farmers able to plant a bigger area (in m²) due to the additional water? Obs: Estimation through farmers' indication
- 2. **Diversification of production**; can the farmers plant additional crops which were not planted before due to lack of water?
- 3. Harvests per year; can the farmers harvest more often than before? (in months)
- 4. **Size of yield**; is the quantity produced larger than before? (Is the farmer self-sufficient and was he before?)
- 5. Change in use of controversial agricultural techniques; can the farmers avoid the use of agrochemicals? (0 = no, 1 = yes) obs: None used agrochemicals

Economic indicators

- 1. **Off-farm employment**; is there a necessity in the family pursue an additional employment? (in R\$ per month)
- 2. Change agricultural revenue; did the family's income change? (in R\$ per month)
 - a. Does the family have sufficient production for personal consumption or do they still have to buy some things?
 - b. Does the family donate part of their production to others (for free)?
 - c. Does the family exchange part of their production?
 - d. Does the family sell more of their production?
- 3. Weekly participation of market; does the farmer go more often to the market? (in times per month)
- 4. Does the farmer have new sales channels: market, CEASA, schools, PENAI
- 5. **Investment in property**; can the farmer reinvest part of its revenue in the infrastructure on the property (house, roads, fences, etc.)?
- 6. **Investments in production factors for farming**; did the farmer invest in a sort of infrastructure or goods, such as storage location, plough, etc.

- 7. Acquisition of goods for consumption/household; did the farmer buy any goods for the household he could not buy before (television, mobile phone, fridge, stove, means of transport, etc.)?
- 8. Other sources of income: bolsa familia, retirement pension, e.g. (in R\$ per month)
- 9. Financing methods/Access to credits: PRONAF

Social

- 1. Water availability; improve (1) or not (0)
- 2. Water quality: improve (1) or not (0)
- 3. Permanence of men and women on the field (hours per day and months per year)
- 4. Location of children: Rural or Urban
- 5. Education level of children; primary school or secondary school, CAV agricultural school?

Communitarian work

- 1. Leadership position: Yes (1) or no (0)
- 2. Participation of community association: active engagement (1), passive (0)
- 3. Participation of Market Association: Yes (1) or no (0)
- 4. **Communitarian purchases**: Yes (1) or no (0)

Appendix 2: Questionnaire

Q1) What was the biggest implication for your family after the intervention?

Production

Q2) Did you change the size of the plantation?

 \Box Increase (approximately <u>m</u>²) \Box No change

 \Box Decrease (approximately ____m²)

Q3) Did you observe a change in the size of the yield?

□ Yes, I am self-sufficient now

□ Yes, I produce more but I was always self-sufficient

□ Yes, I produce more but I am still not self-sufficient

 \Box Yes, I produce less than before

□ No, I was always self-sufficient

 \Box No, I can't observe a change

Q4) Do you plant different crops than before?

□ Yes, I plant more different crops, namely_____

 \square No, I plant the same crops

Q5) Can you harvest in different periods of the year than before?

□ Yes, I harvest _____ months more

 $\square \ No$

Q6) Do or did you use agrochemicals on your plantation?

 \Box Yes, but I stopped

 \Box Yes, I still use

 \square No, I never used

Economy

Q7) Do you exert an off-farm employment?

□ Yes, _____ and I earn approximately R\$_____ per month

 $\square \ No$

Q8) Are you a beneficiary of one or more of the following social governmental policies? (more than 1 choice possible)

□ Bolsa Família: R\$_____

Retirement pension: R\$_____

□ Disabled pension: R\$_____

Q9) Did you increase your salary generated through your production after the construction of the RWH technology?

□ Yes, approximately a monthly R\$_____ more than before

 $\square \ No$

Q10) Do you produce enough for household consumption?

 \Box Yes \Box No

Q11) Do you donate part of your production?

 \Box Yes \Box No

Q12) Do you exchange part of your production with other farmers?

 \Box Yes \Box No

Q13) Where do you sell your production? (Multiple choice possible)

 \Box Local market, ______times a month \Box Supermarkets

 \Box Schools

Q14) How do you mainly spend or invest your money? (More than 1 choice possible)

Acquisition of consumer goods, namely______

Investments in production factors, namely______

	□ Investments in property, namely_	
	Q15) Did you obtain governmental financi	ng (PRONAF)?
	\Box Yes	□ No
Social	l	
	Q16) Do you have better access to water?	(Individual perception)
	\Box Yes	□ No
	Q17) Do you have to order the water truck	less than before the intervention?
	□ Yes, times less per year	□ No
	Q18) Did the quality of the water improve	? (Individual perception)
	\Box Yes	□ No
	Q19) Can you spend more time in the field	due to better water availability?
	□ Yes,hours longer per day	□ No
	Q20) If you have children, where are they	living?
	Rural (in the field) and/or	Urban (towns and cities)
	Q21) If you have children, what is their level	vel of education?
	Primary and	Secondary/EFAV
Comn	nunitarian	
	Q22) Do you exert a leadership position in	your community?
	□ Yes,	□ No
	Q23) Do you actively participate in comm	unity meetings?
	\Box Yes	□ No
	Q24) Do you participate in the local marke	et association?
	\Box Yes	□ No
	Q25) Did you ever benefit from communit	arian purchases?
	\Box Yes	□ No

Q26) Did you participate of the mandatory training of CAV related to the RWH technology?

 \Box Yes \Box No

Q27) Do you participate in CAV's projects related to empowerment of female members?

 \Box Yes \Box No

Complementary

Q28) What are your biggest challenges?

Q29) Do you have other dreams or projects?

	Community	A no	Sov	Childran		Dronarty Ciza (ha)	Watar Harvasting Tachnology	Voar of Construction
	COMMUNIC	7gc	JCA			TTUPETLY STEE (IIA)	Water Hai vesting recurious	
				M (age)	F (age)			
Family 1	Monte Alegre	60	F	0	0	12	2 Ponds	2009
Family 2	Monte Alegre	70	M	NA	NA	NA	2 Ponds	2009
Family 3	Monte Alegre	54	M+F	1 (23)	2 (20+21)	10	1 Pond + 1 Basin	2009
Family 4	Monte Alegre	54	M+F	1(19)	2 (22+16)	NA	1 Pond	2010
Family 5	Monte Alegre	54	M+F	1 (22)	5 (16-28)	NA	Spring installation for community	2010
Family 6	Monte Alegre	56	M+F	1 (23)	2 (18+20)	15	1 Pond + 2 Basins	2010
Family 7	Monte Alegre	41	M+F	1(18)	2 (13+15)	15	2 Ponds + 2 Basins	2011
Family 8	Monte Alegre	46	M	0	0	NA	1 Pond + 1 Basin	2011
Family 9	Monte Alegre	36	M+F	2 (13)	0	26	1 Pond	2012
Family 10	Monte Alegre	56	ц	1(33)	2 (22+29)	NA	1 Pond + 1 Basin	2012
Family 11	Gamileira	39	M+F	1 (22)	2 (13 + 16)	100	1 Pond	2010
Family 12	Gamileira	40	2M	0	0	24	1 Pond	2010
Family 13	Gamileira	53	M+F	0	2 (23+25)	21	1 Pond	2010
Family 14	Gamileira	72	M+F	NA	NA	NA	2 Basins	2010
Family 15	Gamileira	33	M	0	1 (6)	30	1 Pond	2011
Family 16	Gamileira	44	M+F	1(18)	1 (20)	NA	1 Pond	2011
Family 17	Gamileira	47	M+F	1 (22)	2 (19+18)	NA	Downstream of 1 Pond (indirect)	2011
Family 18	Gamileira	63	M+F	1 (NA)	3 (30-NA)	NA	1 Pond	2011
Family 19	Morro Branco	45	M+F	2 (17+19)	0	7	1 Pond + 2 Basins	2012
Family 20	Morro Branco	46	(M)+F	1 (NA)	2 (NA)	NA	1 Pond + 1 Basin + 1 Dike (2014)	2012
Family 21	Morro Branco	52	(M)+F	2 (NA)	3 (13-25)	NA	1 Pond + 1 Basin	2012
Family 22	Morro Branco	68	M+F	NA	NA	NA	1 Pond + 2 Basins	2012
Family 23	Morro Branco	43	(M)+F	1(20)	0	12	2 Ponds + 1 Basin	2012
Family 24	Morro Branco	33	(M)+F	0	13(11-14)	NA	1 Pond	2013
Family 25	Morro Branco	69	M	NA	NA	NA	1 Pond	2013
Family 26	Cuba	34	M+F	1(13)	0	NA	1 Pond + 1 Basin	2013
Family 27	Cuba	46	M+F	2 (16-19)	2 (NA)	NA	1 Pond	2013
Family 28	Cuba	57	M	6(14-35)	2 (NA)	NA	1 Basin	2013
Family 29	Cuba	59	M+F	2 (30+)	3 (30+)	NA	1 Pond	2013
Family 30	Cuba	99	Μ	NA	NA	NA	1 Pond	2013
			(M)=absent					

Appendix 3: Table 8: Data household information

Family	Dry out?	Size of plantation	Size of yield	Product diversification	Harvest period
		(1 = increase, 0 = stay, -1 = decrease)	(1 = increase, 0 = not increase)	(1 = yes, 0 = no)	(1 = increase, 0 = not increase)
1	Every Year	1 (+1ha)	1 (now self-sufficient)	1 (+water-intensive crops + cows)	1 (+5months)
2	never	-1	0 (always self-sufficient)	1 (+water-intensive crops + fish)	1 (+6months)
3	never	1	1 (now self-sufficient)	0	1 (+6months)
4	never	$1 (+70m^2)$	1 (now self-sufficient)	1 (+water-intensive crops and ກາດcessing)	1 (+2months)
L.	NA	-	1 (now self-sufficient)	1 (+water-intensive crons)	1 (+6months)
9	never	·1	1 (now self-sufficient)	1 (+water-intensive crops)	1 (+4months)
7	never	$1 (+50m^2)$	1 (always self-sufficient)	1 (+water-intensive crops)	1 (+4months)
8	never	0	0 (always self-sufficient)	0	0
6	never	1	1 (now self-sufficient)	1 (+water-intensive crops + cows)	1 (+5months)
10	never	$1 (+30m^2)$	1 (now self-sufficient)	1 (+cows)	1 (+5months)
11	2011&2012	1	1 (always self-sufficient)	1 (+water-intensive crops)	1 (+4months)
12	never	1	1 (now self-sufficient)	0	1 (+4months)
13	2011&2013	0	1 (now self-sufficient)	0	1 (+4months)
14	NA	0	1 (not self-sufficient)	0	1 (+5months)
15	2012	NA	1 (now self-sufficient)	1 (+water-intensive crops)	1 (+3months)
16	Every Year	0	0 (not self-sufficient)	0	0
17	NA	1 (+1ha)	1 (now self-sufficient)	0	1 (+4months)
18	NA	0	1 (now self-sufficient)	1 (+water-intensive crops)	1 (+4months)
19	2012&2013	$1 (+80m^2)$	1 (now self-sufficient)	1 (+water-intensive crops)	1 (+3months)
20	NA	0	1 (not self-sufficient)	0	1 (+1-2months)
21	2013&2014	0	1 (now self-sufficient)	0	1 (+3months)
22	never	$1 (+20m^2)$	1 (now self-sufficient)	0	1 (+2months)
23	2013	0	0 (not self-sufficient)	0	1 (+1month)
24	2013	0	0 (not self-sufficient)	0	0
25	never	0	0 (not self-sufficient)	1 (+water-intensive crops)	1 (+2months)
26	never	$1 (+30m^2)$	1 (not self-sufficient)	1 (new veggies)	0
27	never	-1	1 (now self-sufficient)	1 (+cows)	1 (+3months)
28	2013&2014	$1 (+20m^2)$	1 (now self-sufficient)	1 (+water-intensive crops)	1 (+2months)
29	never	0	0 (always self-sufficient)	0	0
30	never	$1 (+30m^2)$	1 (always self-sufficient)	0	0

Appendix 4: Table 9: Data social indicators

: ;									
Family	Income								
	Off-farm	Public Policies	Production				Sales Channels	Investments	Loans
			Sales increase	Consumption	Exchange	Donate	Market	(1=production,	Pronaf
			(compared to Y0)	(1=enough, 0=not	(1=yes,	(1=yes,	(monthly	2=property,	(1=yes,
				enough)	(ou=0	(o=0)	participation)	3=consumption)	0=no)
1	R\$ 0	R\$ 1'440	R\$ 150	1 (R\$ 300)	1	0	2	1, 2	1
2	R\$ 0	R\$ 1'440	R\$ 300	1 (R\$ 120)	1	1	4	1	0
3	R\$ 0	R\$ 790	R\$ 150	1 (R\$ 240)	1	0	4	1, 2	0
4	R\$ 0	R\$ 720	R\$ 900	1 (R\$ 300)	+	0	4	1, 2	1
S	R\$ 0	R\$ 720	R\$ 150	1 (R\$ 360)	0	Ť,	2	3	0
9	R\$ 0	R\$ 1'510	R\$ 900	1 (R\$ 240)		NA	6	1, 2	0
7	R\$ 400	R\$ 100	R\$ 700	1 (R\$ 300)	0	1	4	2, 3	1
8	R\$ 270	R\$ 0	R\$ 0	1 (R\$ 60)	1	0	0		0
6	R\$ 360	R\$ 100	R\$ 600	1 (R\$ 240)	T	÷	2	1, 2, 3	0
10	R\$ 0	R\$ 720	R\$ 150	1 (R\$ 120)	ᠽ	ᠽ	2	1, 2	0
11	R\$ 400	R\$ 132	R\$ 1'600	1 (R\$ 240)	1	1	4	1, 2, 3	NA
12	R\$ 720	R\$ 0	R\$ 1'000	1 (R\$ 240)	NA	NA	4	1, 2, 3	-1
13	R\$ 0	R\$ 100	R\$ 750	1 (R\$ 120)	T	÷	4	1, 2	1
14	R\$ 0	R\$ 1'440	R\$ 0	0	н	NA	0	1, 2	0
15	R\$ 1100	R\$ 60	R\$ 0	1 (R\$ 180)	0	ц,	0	1, 2	0
16	R\$ 0	R\$ 1'100	R\$ 0	0	0	0	0		0
17	R\$ 1000	R\$ 0	R\$ 1'400	1 (R\$ 300)	0	сц	*0	1, 2	1
18	R\$ 0	R\$ 780	R\$ 330	1 (R\$ 180)	1	1	4	1, 2	
19	R\$ 800	R\$ 100	R\$ 600	1 (R\$ 240)	T	÷	4	1, 2, 3	0
20	R\$ 760	R\$ 820	R\$ 0	0	0	0	0	1, 2, 3	-1
21	R\$ 760	R\$ 160	R\$ 0	1 (R\$ 240)	7	Ļ	0	NA	0
22	R\$ 0	R\$ 1'440	R\$ 0	1 (R\$ 120)	1		0		0
23	R\$ 1'520	R\$ 70	R\$ 0	0	1	0	0	1, 3	0
24	R\$ 800	R\$ 160	R\$ 0	0	1	0	0	2	0
25	R\$ 760	R\$ 870	R\$ 0	0	1	0	0	1	0
26	R\$ 400	R\$ 790	R\$ 0	0	1	0	0	1, 3	0
27	R\$ 0	R\$ 100	R\$ 30	1 (R\$ 240)	1	1	0	2, 3	0
28	R\$ 0	R\$ 820	R\$ 0	1 (R\$ 180)	1	0	0	2	0
29	R\$ 0	R\$ 720	R\$ 0	1 (R\$ 120)	0	0	0	1, 2	0
30	R\$ 0	R\$ 720	R\$ 100	1 (R\$ 120)	1	1	0	2	0
* sells to	supermarke	ts and schools							

Appendix 5: Table 10: Data economic indicators

Family	Water			Permanence in t	he field (h/day)	Location (of children	Education (1=yes, 0=	of children no)
	Availability	Water Truck (times	Quality	Male	Female	Rural	Urban	Primary	Secondary
·	(0=same, 1=1mprove)	less than before)	(0=same, 1=improve)	(increase)	c	¢	c		
-	Ι	n	1	+3h	0	0	0	NA	NA
2	1	2	1	+2h	0	0	2	1	1
e	1	2	1	0	+1h	0	m	1	1
4	1	1	1	+3h	+1h	2	1	1	1 (EFAV)
S	NA	0	NA	+2h	+1h	2	4		1 (EFAV)
9	1	2	1	NA	NA	2	1	1	1 (EFAV)
7		0	1	0	+1h	e	0		1
8	0	0	0	0	0	0	0	NA	NA
6	1	0	1	0	0	7	0	1	0
10	1	0	1	NA	+2h	1	2	1	1
11	1	0	1	0	0	7	1	1	1
12	1	0	1	+4h	0	0	0	NA	NA
13	1	1	0	+3h	+2h	0	2	1	1
14	0	1	1	NA	NA	NA	NA	NA	NA
15	NA	0	0	0	0	0	1	1	0
16	0	0	0	0	0	0	2	1	1
17	1	2		0	+5h	0	3	1	1 (EFAV)
18	1	1	1	0	+2h	0	4	1	1
19	1	0	1	+4h	+2h	7	0	1	1
20	1	0	1	0	+2h	1	2	1	1
21	0	0	0	0	0	3	2	1	1
22	1	1	1	+1h	0	NA	NA	1	1
23	NA	0	NA	0	0	7	0	1	1 (EFAV)
24	0	0	NA	0	0	3	0	1	1
25	1	0	NA	NA	+2h	б	1	NA	NA
26	1	2	1	+1h	+2h	1	0	1	0
27	1	0	1	+1h	+1h	7	2	1	1 (EFAV)
28	1	1	1	+2h	0	2	6	1	1
29	1	0	0	0	0	0	5	NA	NA
30	1	0	1	0	0	4	-	NA	NA

Appendix 6: Table 11: Data social indicators

Family	Leadership	Participation Community	Market	Community
J		Meetings	Association	Purchases
	(0=no, 1=yes)	(0=passive, 1=active)	(0=no, 1=yes)	(0=no, 1=yes)
1	0	0	1	1
2	0	0	0	1
3	0	1	1	1
4	0	1	0	1
5	1 (supplies 12 fam. with water)	1	1	1
6	0	1	1	1
7	0	1	0	0
8	0	1	0	0
9	0	1	1	1
10	0	1	1	1
11	0	1	1	1
12	0	1	1	1
13	0	1	1	1
14	0	0	0	0
15	0	0	0	0
16	0	1	1	0
17	0	1	1	1
18	1 (practical teacher EFAV)	1	1	1
19	1 (organizes community meetings)	1	1	1
20	0	0	0	0
21	0	1	0	0
22	0	1	0	0
23	0	0	0	0
24	0	0	0	0
25	0	0	0	0
26	1 (quilombola community)	1	0	0
27	0	1	0	0
28	0	1	0	0
29	0	0	0	0
30	0	0	0	0

Appendix 7: Table 12: Data communitarian indicators

Appendix 8:

Family	Year of construction	Income 2014	S1	S2	S 3
1	2009	R\$ 150	NA	NA	R\$ 412
2	2009	R\$ 300	NA	NA	R\$ 540
3	2009	R\$ 150	NA	NA	R\$ 850
4	2010	R\$ 900	0	R\$ 108	NA
5	2010	R\$ 150	R\$ 130	NA	NA
7	2011	R\$ 700	R\$ 540	NA	0
11	2010	R\$ 1600	R\$ 260	R\$ 260	NA
13	2010	R\$ 750	R\$ 325	R\$ 340	NA
14	2010	R\$ 0	R\$ 0	R\$ 36	NA
18	2011	R\$ 330	R\$ 250	NA	0
Average			R\$ 215	R\$ 195	R\$ 360

Table 13: Purchase of organic fertilizer of families per season

Appendix 9:

Table 14: Expenditure in organic fertilizers per family in municipality of Veredinha 2014

Family	Expenditure	Family	Expenditure	Family	Expenditure	Family	Expenditure
1	577.15	12	192.00	22	96.00	32	192.58
2	192.00	13	192.00	23	96.00	33	413.95
3	480.00	14	96.00	24	192.00	34	384.00
4	384.00	15	136.13	25	192.00	35	288.00
5	192.96	16	384.00	26	774.72	36	384.00
6	94.66	17	192.00	27	576.00	37	768.58
7	193.92	18	384.00	28	774.72	38	599.04
8	98.11	19	768.00	29	384.00	39	146.69
9	195.84	20	768.00	30	288.38	40	118.08
10	99.07	21	71.04	31	356.35	41	1387.78
11	96.00						

Source: CAV (2014). Obs.: Family number not corresponding to families of

Арр	endix 10:	Table	15:	CHF-BRL	exchange	rate and	annual	inflation	in	Brazil
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Year	CHF	BRL	Inflation	Year	CHF	BRL	Inflation
2009	1	1.65	4.3%	2014	1	2.50	6%*
2010	1	1.65	5.9%	2015	1	2.74*	6%*
2011	1	1.70	6.5%	2016	1	3.00*	6%*
2012	1	1.90	5.8%	2017	1	3.29*	6%*
2013	1	2.00	5.9%	2018	1	3.60*	6%*

*Estimations according to trends from 2009 to 2013

Source: Vivamos Mejor and Brazilian Central Bank (2014).

Appendix 11: Economic payback calculations

Table 16: Economic payback calculation 2009

Investments 2009 = *CHF* 62'517

Annual Individual Income (of	Beneficiaries (in	Total Income Generated (by all	Value still to be
agriculture in the year)	2009)	farmers)	amortized
2010 (y1) = CHF 32	*17	CHF 544	CHF 61'973
2011 (y2)= CHF 1'015	*17	CHF 17'225	CHF 44'748
2012 (y3) = CHF 1'766	*17	CHF 30'022	CHF 14'726
2013 (y4) = CHF 2'985	*17	CHF 50'745	-
2014 (y5) = CHF 780	*17	CHF 13'260	

Amortization time = 3.29 years

Table 17: Economic payback calculation 2010

Investments 2010 = *CHF* 170'482

Annual Individual Income (of	Beneficiaries	Total Income Generated (by	Value still to be
agriculture in the year)	(in 2010)	all farmers)	amortized
2011 (y1) = CHF 33	*27	CHF 891	CHF 169'591
2012 (y2)= CHF 967	*27	CHF 26'109	CHF 143'482
2013 (y3) = CHF 1'776	*27	CHF 47'952	CHF 95'530
2014 (y4) = CHF 2'528	*27	CHF 68'256	CHF 27'274
2015 (y5) = CHF 754	*27	CHF 20'358	CHF 6'916
2016 (y6) = CHF 1212	*27	CHF 32'724	-

<u>Amortization time = 5.21 years</u>

Table 18: Economic payback calculation 2011

Investments 2011 = CHF 147'245

Annual Individual Income (of agriculture in the year)	Beneficiaries (in 2011)	Total Income Generated (by all farmers)	Value still to be amortized
2012 (y1) = CHF 32	*53	CHF 1'696	CHF 145'549
2013 (y2)= CHF 972	*53	CHF 51'516	CHF 94'033
2014 (y3) = CHF 1'504	*53	CHF 79'712	CHF 14'321
2015 (y4) = CHF 2'445	*53	CHF 129'585	-
2016 (y5) = CHF 730	*53	CHF 38'690	-

<u>Amortization time = 3.11 years</u>

Table 19: Economic payback calculation 2012

Investments 2012 = CHF 134'875

Annual Individual Income (of	Beneficiaries	Total Income Generated (by	Value still to be
agriculture in the year)	(in 2012)	all farmers)	amortized
2013 (y1) = CHF 32	*19	CHF 608	CHF 134'267
2014 (y2)= CHF 824	*19	CHF 15'656	CHF 118'611
2015 (y3) = CHF 1'455	*19	CHF 27'645	CHF 90'966
2016 (y4) = CHF 2'367	*19	CHF 44'973	CHF 45'993
2017 (y5) = CHF 706	*19	CHF 13'414	CHF 32'579
2018 (y6) = CHF 1'077	*19	CHF 20'463	CHF 12'116
2019 (y7) = CHF 1'077	*19	CHF 20'463	-

<u>Amortization time = 6.59 years</u>

Table 20: Economic payback calculation 2013

Investments 2013 = CHF 84'810

Annual Individual Income (of agriculture in the year)	Beneficiaries (in 2013)	Total Income Generated (by all farmers)	Value still to be amortized
2014 (y1) = CHF 27	*34	CHF 918	CHF 83'892
2015 (y2)= CHF 787	*34	CHF 26'758	CHF 57'134
2016 (y3) = CHF 1'408	*34	CHF 47'872	CHF 9'262
2017 (y4) = CHF 2'288	*34	CHF 77'792	-

-

2018 (y5) = CHF 684

CHF 23'256

<u>Amortization time = 3.12 years</u>

*34

Appendix 12: Pictures

Picture 1, Excavation of a barraginha



Picture 2, *barraginha* filled with water



Picture 3, construction of a *dique* by joint effort



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The Undersigned hereby undertakes and warrants to treat any information obtained by the enterprise/ administration concerned in strict confidence. In particular, he / she shall only permit people other than the referees to inspect his / her written work with the express consent of all the parties that have provided information.

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