Characterization and Sustainability Assessment of Pineapple-based Cropping Systems in Costa Rica: A baseline study for sustainable sourcing of organic pineapple

Name student: Maria Pia Gamboa

Period: 2013-2014

Farming Systems Ecology Group
Droevendaalsesteeg 1 – 6708 PB Wageningen - The Netherlands

WAGENINGEN UNIVERSITY
WAGENINGEN UR

(title page)

Characterization and Sustainability Assessment of Pineapple-based Cropping Systems in Costa Rica: A baseline study for sustainable sourcing of organic pineapple

Name student(s): Maria Pia Gamboa
Registration number student: 870821-249-090
Credits:
Code number: FSE
Name course:
Period:
Supervisor(s): Dr. Johannes Scholberg and Walter Rossing
Professor/Examiner: Dr. Pablo Tittonell

Preface

The starting point for this thesis was an internship at EOSTA the largest importer of fresh organic produce in Europe that is located in the Netherlands. As part of this internship I was asked by Henk Zoutwelle, pineapple buyer from EOSTA and a member of the Sustainable Pineapple Alliance (SPA), to engage in a desk study aiming to research and design more sustainable and diverse pineapple-based cropping systems in Costa Rica. Upon the completion of this internship it was decided that an additional in-country farm and production chain characterization was warranted to better assess the current situation. The thesis was supervised by Johannes Scholberg and Walter Rossing (WUR-FSE), the latter being also instrumental in structuring follow-up project activities.

The subject of this thesis was very relevant to me because as a Costarican citizen I am concerned about the current production practices in pineapple and organic agriculture. Working several years in organic certification as an inspector in Costa Rica, I visited several organic agricultural projects. Even though regulations exist I had my doubts of the long-term sustainability of these farming systems. A crop like pineapple in Costa Rica has caused considerable environmental damage in the areas and communities where they are being cultivated. Moreover, most of the conventional producers, which transitioned into organic, did not have a truly organic production philosophy. Rather they tended to simply take conventional practices and adapted them to comply with local certification standards. As a result, there are many technical gaps for organic plant production in several crops, especially for a crop that is intensely produced like pineapple. Besides my interest in improving agricultural practices, I want to support small family farms and provided them with alternative business models that will enable them to enhance food security and for their organic farms to be economically to be more viable. Throughout this study, different actors have expressed doubts of smallholders being able to organize themselves and to be successful as an export business of high quality produce. However, I believe this is possible but there is the need to provide adequate technical during the initial transition. Based on local research in order to improve practices and organizational schemes for producers.

During my thesis research I observed that there are very pronounced differences between the practices of producers which export and producers which sell in the local market. It appears that the differences and diversity in product quality standards and corresponding skills of different types of producers may be used to support a co-innovation process. This may entail effective exchange of different farming practices to structure best fit technologies to enhance more sustainable and efficient systems. Even though some producers reject the concept of working together, specially the larger farms, an exchange of information among them may support development of more sustainable cropping systems. Through this study I hope to provide a basis to inspire future developments. Thereby hope to contribute to the development of a more sustainable value chain for pineapple during a subsequent stage of this ongoing initiative and consolidate these efforts in a larger international supported project.

Acronyms

AF (Agro ecological Farm)
CANAPEP (Cámara Nacional de productores y exportadores de piña/National Association of Pineapple producers and exporters)
CF (Conventional Farm)
MAG (Ministry of Agriculture and Livestock)
MESMIS (Spanish acronym for Indicator-based Sustainability Assessment Framework)
MM (Mountain Microorganisms)
OA (Organic Agriculture)
OF (Organic Farm)
PROCOMER (Promotora del comercio exterior de Costa Rica /Foreign trade Promotor of Costa Rica)
RHN (Región Huétar Norte)
UNA(National University of Costa Rica)
UCR (University of Costa Rica)
WUR-FSE (Wageningen University _Farming Systems Ecology group

Abstract -Executive Summary

Sustainability assessment as basis for development of sound farming practices has become a key focus for many researchers, policy makers and development studies throughout the world. There is increased interest in creating multifunctional systems. Such systems can enhance farmer's livelihoods, reinforce local food security, preserve natural resources, improve (bio)diversity, among many more socio-ecological functions and services, which is essential in the context of structuring sustainable farming systems.

As mentioned above this paper examines overall sustainability of existing pineapple-based systems in Costa Rica, comparing different farming systems, conventional as well as organic. The sustainability assessment is based mainly on the MESMIS framework as well as other methodological approaches. The DEED (Giller et al., 2008) conceptual framework was used to guide the overall farming system analysis and data collection was structured such to facilitate farm characterization. This information was also linked to the entire value chain and different actors and stakeholders were engaged throughout the whole analysis process. The overall aim was to generate change in these systems based on effective use of participatory approach and co-innovations techniques thereby providing a broad basis for a subsequent re-design phase.

Existing tools and diverse activities such as farm surveys, expert interviews, farm typology; problem trees, workshops and were used to develop a method to characterize farms and their sustainability. As part of this process the in-depth characterization was linked with the decision making process of farmers targeting improvement of their livelihood via initial assessment of viable farming designs alternatives. A guideline documenting this entire process is presented in the different chapters of this thesis.

These guidelines aimed to define the necessary steps, best methods to gather required information necessary as a prerequisite of the re-designing of local systems. This of course based on the explicit needs of farmers, government, policy makers, importers, and buyers among other stakeholders.

In the case of RHN the multivariate analysis revealed the existence of 7 farm types in the northern region of Costa Rica, small: macro/ micro mixed farming systems and micro/macro monoculture systems, medium, big and organic farms. The typology obtained from this research exposed vital information, making the acknowledgment that there are still mixed farming systems among pineapple growers. The need to study the resource use efficiency and farm performance should be explored further. The wide variety of farmers presented in the study might have differences in resource use efficiency and farm performance not identified with the quantitative data gathered during this research study. The farmers do not collect or annotate

certain information of importance for this study. The data missing includes information on soil samples, rotation schemes, input use and costs, application rates, among more variables. The lack of data from the farmers made this analysis not possible. Even though during this research the comparison of only three farms: big conventional, big organic for export market and small organic for local market was completed in more detail. Big organic farms were found to be more intensive than conventional farms by using more resources, labor and obtaining similar yields. An interesting finding from the producers of this region is that their agricultural practices vary widely depending of the market orientation, weather is local or for export as well as their farm size. Identification of characteristics of farmer is essential in order to developing suitable strategies for agricultural planning at different levels like policymaking, individual farm strategies, or organizational schemes for different sized producers

In conclusion how can this findings help design new strategies for farmers according to their needs and differences? Is this the case for all medium, small farms oriented to exports markets? Or are their further differences depending on size/market? Can alternative more sustainable farming practices be implemented in more intensive big organic farms? Can small and big farms exchange practices to have better farm performances and become sustainable throughout time? Many more questions aroused after this research project.

Table of Contents

Index of Tables

Index of Figures

1. Introduction

1.1 Global Trends and developments

Consumer demand for organic food supply is increasing continuously every year with consumers being concentrated in Europe and the USA (97% of global revenues, See Fig. 1). Consumers are increasing aware and demand to be informed where their food comes from, how safe it is, how it was produced and how sustainable the product they purchase is. As a result CEOs, food industry and agribusiness are required to meet expectations of consumers regarding sustainability and transparency in order to compete in increasingly globalized value chains (Bremmers et al., 2011). Supermarkets in Europe are the fastest growing in organic supply to consumers with bio-shops end eco-markets available. Even though, organic has entered into mainstream markets and is being embraced by retailers like: Lidl, Albert Hein, Plus, Tesco, among others. (Willer et al. 2009)

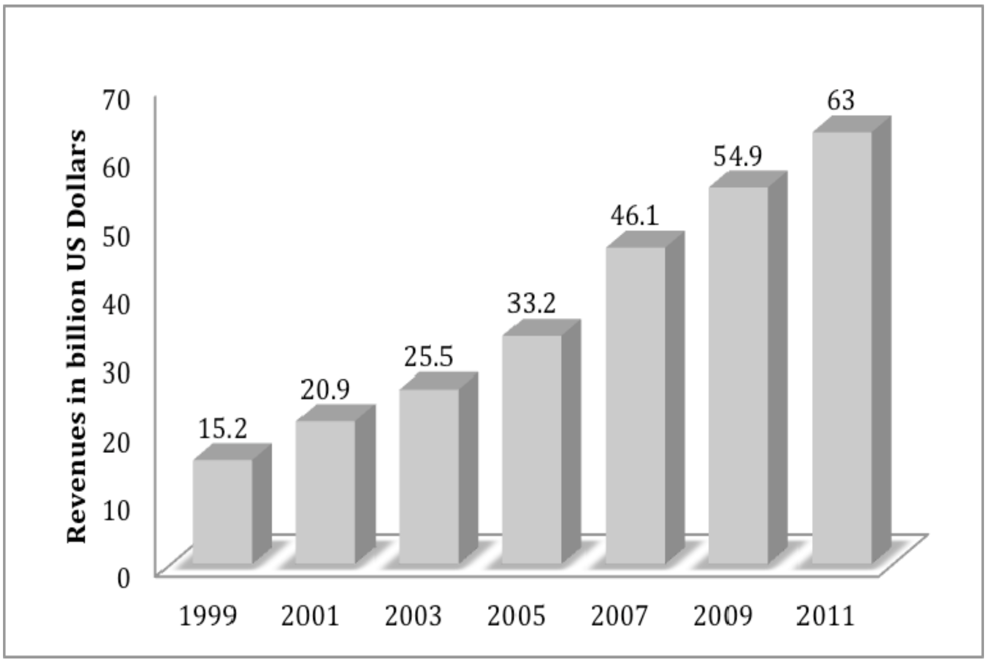

Figure 1.The global market for organic food and drink: Market growth from 1999-2011. Source: Willer et al. 2009

Other regions such as Asia, Latin America and Africa are important producers and exporters of sustainable food products. Food chains and big companies are aware of steep increase in consumer demands for sustainably and/or organically produced products. Even though demand is growing, production is growing much slower and even stagnating in important producer countries. Currently the supply of many raw materials and fresh products lag behind demand. Increasing production capacity in a sustainable manner requires investments in infrastructure, logistics, storage/package/processing facilities and development of technical skills and producer networks. (Willer et al. 2009)

Large companies are increasingly aware of the bottlenecks and at times are required to invest in research, capacity building, and local infrastructure to secure future supplies. This process is referred to as sustainable sourcing. In this context, EOSTA, one of the largest traders in organic produce in Western Europe aims to further evaluate new business models to assure a constant supply of high quality organic pineapple. They are especially concerned about the future of their main supplier of organic pineapple (Costa Rica). For this reason there is a mayor interest in creating new business models, which can lead eventually to a broader supply of organic products (tropical fruits and tubers)(Interview Henk Zoutwelle, pineapple buyer EOSTA, 2013)

To identify viable options for a more sustainable agriculture production, proposed development strategies should be focused on the optimization of the entire farm and include the assessment of different farm components (Dogliotti et al 2013). This process may involve farm characterization, farmer interviews, and more detailed studies of selected farms for sustainability assessments. Change should revolve around the context of identifying steps and features to design and develop viable integrated management practices and production strategies, based on key problems identified by farmers and researchers during a co-innovation process (Rossing et al. 2010). Part of the challenge of this process is to develop standards and methods to monitor and compare changes in sustainability parameters between production systems and/or practices in a transparent and consistent manner.

1.2 History and Background

Costa Rica has become the world's number one exporter of fresh pineapple. Large-scale production started in the 1980s after PINEDCO S.A., a subsidiary of Del Monte, started their operation in the southern region of Costa Rica. (Aravena, 2005). The introduction of new varieties, which are more suitable for export like the white Hawaiian pineapple, governed drastic changes within the sector, which only comprised 3400 hectares in 1986. After the introduction of MD2 by Del Monte during the mid-90s, the production area grew to 45.000 hectares by 2010 (Quijandría, 1997). The exponential growth of surface used by the industry led to specialization of production, which implied that standard technological production package were being promoted and adapted to ensure uniform quality and the highest possible yields (Maglianesi, 2013).

Currently, the biggest importer of Costa Rican pineapples is Europe (50 %) followed by the US (43%). Moreover, exports to Europe increased between 2000 and 2008 from 0.16 to 0.67 million tons, while the market share increased from 36 to 73% (EOSTA-ICCO, 2010). Thereby Costa Rica is dominating the global pineapple markets. However, the scaling of production is associated with appreciable environmental costs including excessive soil erosion, pesticide contamination of waterways, and increased workers exposure to agrochemicals, which pose a serious health risk (Acuña, 2004).

In terms of farm operations, the production chains and export market are being dominated by Transnational companies like Del Monte, Dole and Chiquita and large producers, while the environmental costs are posing a major threat in terms of long-term sustainability (Emanuelli et al, 2009). Currently, 35% of the total production area belongs to trading companies while 65 % are independent producers that may be linked to local cooperatives and associations of small and medium producers. In terms of farm size distribution, there is an estimated of 1200 small (below 50 hectares) and medium-scale producers (50-250 hectares) that account for 5 to 10 % of the total production of the country. (Kellon et al, 2011). Currently the Ministry of Agriculture (MAG) is re-assessing these numbers since it appears that most of the pineapple production has been controlled by large transnational companies; while small producers are losing their farms due to debts and increased production costs (Personal Communications Jairo Serna on October, 2013).

1.3 Problem Statement

As a developing country, Costa Rica is focused on economic growth and shift from a growth model focusing on local markets to a development model targeting global economy and international markets (Acuña, 2004). Thereby it relies greatly on agricultural exports to support economic development and international trade. The expansion of pineapple was accelerated via governmental policies and subsidies aiming to support new agro-export products like pineapple (Richardson et al, 2013). However, this policy also jeopardized the livelihoods of small and medium farmers, which are vulnerable and did not benefit from this development. Policy measures stimulated the production of untraditional crops while displacing traditional crops including cassava, sweet potato, and dairy production, among other activities. Ultimately this led to the increased imports of food and loss of local food sovereignty, a decline in many food crops, abandonment of family farms and migration of "Campesinos" to urban areas. (Maglianesi, 2013 and Emanuelli et al, 2009). Around 2006 the business was very profitable with payments up to 0.47 $/kg for conventional pineapple (Fig. 2). During this time many producers shifted all their cultivation areas to pineapple. Family-based farms had to adapt to the external forces governing the sector in order to specialize (Emanuelli et al., 2009). This implied increased dependence on agrochemicals, external labor and machinery. (Richardson et al., 2013 and Acuña, 2004). The rapid expansion of land planted with pineapple led to overproduction and a price decrease (Fig. 2). This especially affected small producers, due to poor access to global marketing networks, lack of bargaining powers, financial buffers and infrastructure to commercialize pineapple. Their only option was to rent out land or sell their farms altogether. As a result, large companies and intermediaries increasingly controlled external distribution markets, which further undermined the existent of small family-based farms. (Faure, 2002 and Aravena, 2005). According to figures of the National Production

Board (Consejo Nacional de Producción), only 4% of pineapple production is in the hands of small producers (Emanuelli et al, 2009).

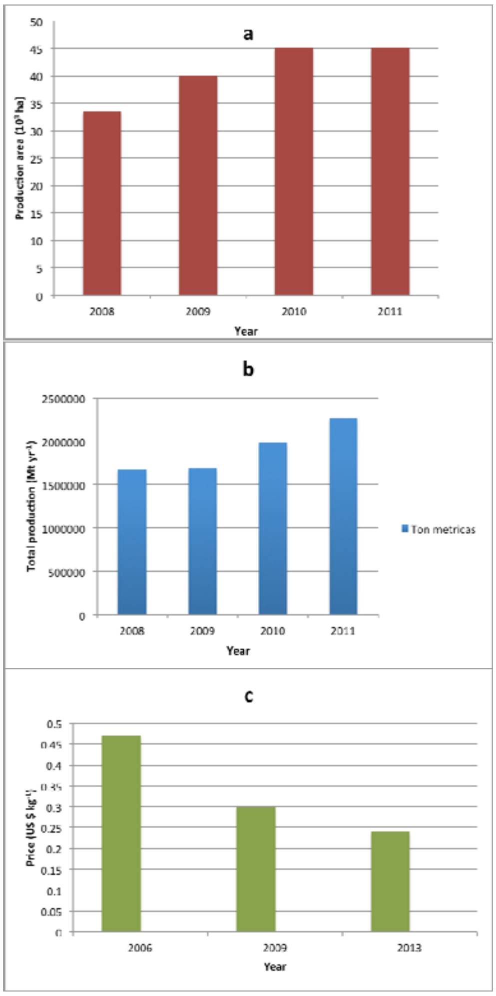

Figure 2. Overview of production area (a), total production (b) and farm gate price (c) for the pineapple industry in Costa Rica between 2006 and 2013.

Pineapple Producers loose their lands because of delay on paying bank loans.

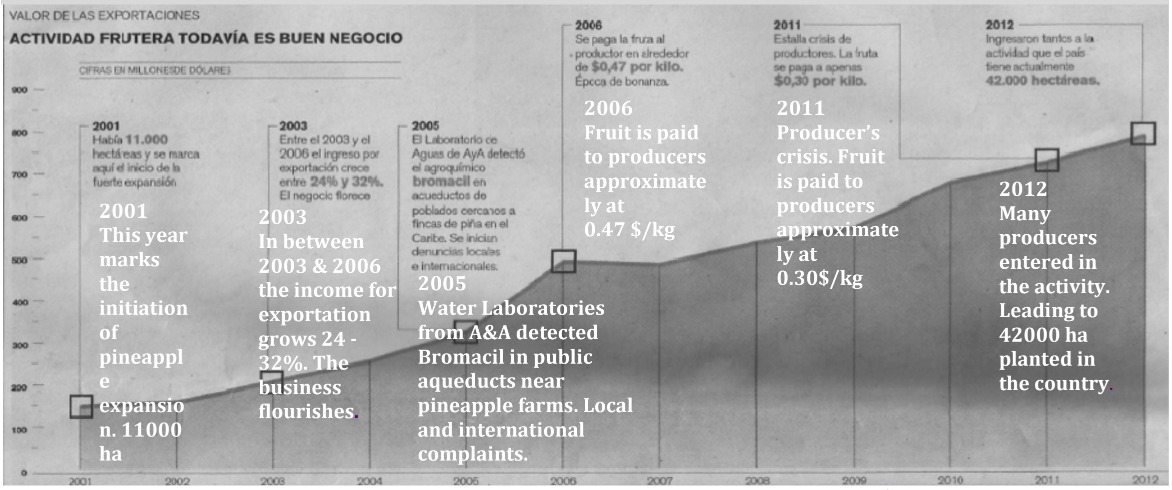

Figure 3. Costa Rican newspaper La Nación pg 20A. Published on the 20th of June 2013. The newspaper shows a timeline from 2001, when the rapid expansion of the pineapple industry took place, until 2012. Translation in white.

In figure 3 the national news of Costa Rica (La Nación) illustrates a time line introducing the rapid rise of the pineapple business and the consecutive decrease in price ($/kg) (Figure 1 and 2). This is a common situation for many of the producers of RHN (Region Huetar Norte) where the majority of private producers are located. According to this article the most affected communities from RHN are Pital, Upala and Guatuso. A study conducted by MAG indicated there are about 350 pineapple farms that are having bank loans, of which around 200 are up to date with payments, 100 are facing financial problems and 50 have no longer any option but to pay the debt with their lands (La Nación, 2013).

Besides market and management issues, producers and local communities are facing many other problems (Emanuelli et al 2009). A study conducted by EARTH University in Costa Rica highlighted the most important concerns of small farmers:
“i) soil erosion, loss of inherent soil fertility and reduced crop productivity
ii) Deforestation
iii) Poor residue management resulting in swarms of *Stomoxys calcitrans* flies that attack cattle on large beef cattle farms and reduce weight gains
iv) Sedimentation and clogging of water basins
v) Contamination and degradation of water resources by high use of pesticides" (Kellon et al, 2011).

Besides the issues presented above, farmers do not see or recognize the effect these plantations are having on their farms and surrounding communities. Prevailing issues, are related to social and environmental problems including low work stability, immigration from urban areas to cities, loss of crop diversity and food security, dependency on supply companies and crop resistance to pesticides (Acuña, 2009).

In the research by Kellon et al in 2011, it was concluded that large –medium scale producers have highly skilled personnel (agronomic engineers) to manage production and logistics. Small-scale producers, on the other hand, usually receive technical support from representatives of agrochemical retailers which advice them on pest control and fertilization issues. However, these representatives are rarely agronomists and may have conflicting interests, so the small-scale producers do not trust their advice, but still have no other technical support. Some producers argue that there is a lack of assistance from the local authorities (MAG). Therefore, some growers have developed their own production schemes based on experimentation, but it appears that there is a very limited communication and transfer of technology among growers (Fig. 4).

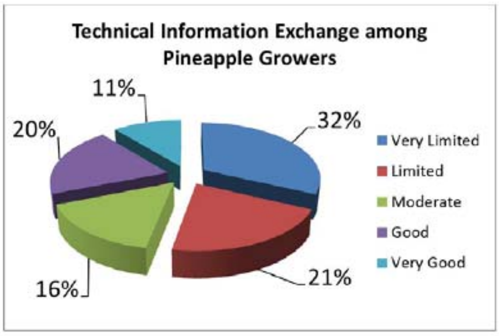

Figure 4. Pineapple grower's opinion about the exchange of technical information within the sector. (Kellon et al, 2011)

Based on the problems presented above, some of the actors in the pineapple sector in Costa Rica perceived that current production practices are not sustainable. Given the competing costs and benefits of pineapple production, many Costa Ricans are beginning to request for more stringent regulation of crop production practices. Policy options being discussed include more severe regulations and monitoring of the existing pineapple industry (Richardson et al 2013). This can eventually jeopardize family-based and private commercial farms in Costa Rica. The information presented above and throughout the thesis highlights farmer's perceptions of prevailing issues undermining the sustainability of their lively hoods and the global value chain. This study provides a baseline and clear justification for a large internationally supported project aiming to provide information and technical support during development of an alternative business model for pineapple and/or other tropical crops.

1.4 Knowledge Gaps

When reviewing the general literature on production trends in pineapple-based production systems as related to global value chains reveals a large variety of covered themes. The existing literature focused mainly on analyzing the environmental impact of pineapple, defined sound agricultural practices, soil conservation measures, residue management etc. However, there is a tendency to generalize production practices across farms without considering difference between farms as related to inherent diversity within the farm population. In the literature the farm typologies were based on variables such as farm size (ha), ownership of a packing station, market orientation, adoption of good agricultural practices and access to financial resources (Piñeiro, 2007). However, there was no or little information on variables like crop diversity, planting densities, type of production (organic or conventional), and use of family labor, among others. It is argued that such variables might lead to an improved assessment of the diversity of practices among producers and the impact of current farming systems[1] of overall system performance (sustainability indicators). Moreover, most of the previous efforts tended to use either a top-bottom approach with little or no information being presented to the farmers. Furthermore, there was no dialogue with farmers regarding viable alternatives and/or guidelines how to structure and implement new business models that can help them to diversify their operations and become more competitive. Although small- and medium-sized farms have formed cooperatives (e.g. Coopepiña and Coopepiagua which were visited during field visits) to facilitate the production and marketing, these cooperatives still face logistical and organizational difficulties, financial problems that jeopardize the existence of their members (Interview Leonidas Chaves, President Coopepiagua, October 2013).

1.5 Research Objectives

1.5.1 Main Objective

The sustainability of prevailing and alternative pineapple-based farms should be assessed because the long-term sustainability of the sector is questionable. To do so characterizing farmers according to size and resource endowment is a first step that is essential to find out how different farms types farms may differentially be developed.

[1] Population of individual farm systems that have similar resources, patterns, household livelihoods and constraints Includes crop choices and animals. (Madry et al. 2013)

The overall aim of thesis is to characterize current pineapple-based farming systems and to evaluate their performance in terms of a select set of sustainability indicators, thereby identify viable options during a subsequent redesign phase.

1.5.2 Specific Objectives

- Develop a farm typology in order to identify different clusters of existing farm types in RHN, the case study area in Costa Rica. During this characterization, participatory approach techniques were used, such as: interviews and workshops.

-In-depth analysis of selected farms in terms of farm structure, production practices, prices and profitability for farms contrasting in market outlets (global vs. local markets and/or size of their operation (large vs. small). This in order to gain a better insight into resource allocation and product management including input use, production efficiencies and yields for farms representative of the different clusters of producers. These methods allowed for improved assessment of farm performance in terms of environmental and socio-economic indicators with special reference to soil quality, which had been identified as being one of the mayor issues.

1.6 Research Questions

1.6.1 Main research question

How can the sustainability of the pineapple farming systems be improved based on farm size, resource endowment and external forces shaping the agricultural landscape in Costa Rica?

1.6.2 Specific Questions

The main research questions included the following:

1) What are the main characteristics of the pineapple industry and which are the main internal and external forces shaping the Costa Rican pineapple industry?

2) *What is the diversity of pineapple farming systems in Costa Rica and does farm size and market orientation affect sustainability of farm, resource use and productivity?*

3) *What are perceived production and marketing constraints of pineapple producers of different size and /or resource endowment?*

These research questions also provide a structural framework for subsequent methodology, results and discussion sections as shown in Table 1.

Table 1. Linkage of research Questions to methodology, information sources, deliverables and relevant citations

Research Question	Methodology Used/ Tools	Information sources	Targeted deliverables	Key citations
What are the main characteristics of the pineapple industry and which are the main internal and external forces shaping the Costa Rican pineapple industry?	Literature Review Problem Trees	Journals/Article Books Interviews/ Meetings with actors/ Interviews/ Literature Review	Profiling of pineapple industry in Costa Rica in the context of global developments during the past 15 years. Problem trees for 3 types of clusters. Material for the workshop.	Dogliotti, S. et al 2013
What is the diversity of pineapple farming systems in Costa Rica and does farm size and market orientation affect sustainability of farm, resource use and productivity?	Farm Typology SWOT Analysis Cluster Analysis MCA (Multiple Correspondence Analysis) Sustainability Indicators ISAP (Indicators Sustainable Agricultural Practices) MESMESIS Analysis	Answers Surveys/ Farm Visits Workshop Literature Review Interviews with stakeholders and farm managers.	Main differences among farm groups. Stronger knowledge and analysis for a design phase of new business models and organizational skills.	G. Faure, 2002 R Development Core Team, 2013 Dogliotti, S. et al 2013 Lopez-Ridaura, S. et al, 2002.
What are perceived production and marketing constraints of pineapple producers of different size and /or resource endowment?	Participatory Approach Techniques	Literature Review Interviews Knowledge on the sector and shareholders. Workshop	Clear understanding of variances of the pineapple farming systems depending on their size and resources.	Rigby, D. et al. 2001 . Dogliotti, S. et al 2013

1.7 Thesis Scope

Some of the key operational steps underlying this thesis that are corresponding to the Describe and Explain phases of the DEED approach outlined by Giller et al 2008 (Fig. 5). In this manner we aim to also integrate some of the above-stated research objectives and provide a structural framework for some of the different thesis components.

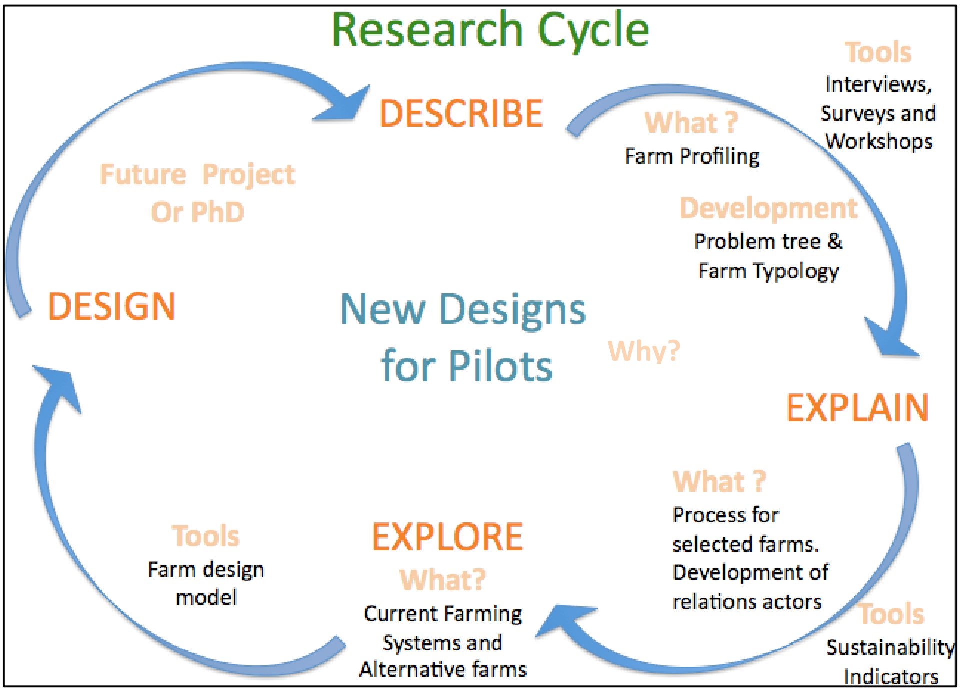

Figure 5. Diagram describing the research components. DEED Cycle Adapted. (Giller, K. E., et al. 2008.)

In preparation of an initial diagnosis the use of a scientific basis participatory approach techniques were effectively engaged with local stakeholders. In this manner we also aim to provide a clear guideline for structuring pilot projects targeting small holders pineapple producers in Costa Rica. This thesis thus contributes as a first step to guide farmers in Costa Rica during the continuous exploration process in search of more sustainable production systems.

2.Materials and Methods

The following sections correspond to the methodology implemented to answer the main research questions. The first main section is related to methodological approaches employed during the overall characterization of the pineapple industry along with a biophysical and socio-economic description of the production region. The last is including main internal and external forces shaping the pineapple industry. The second section refers to methods used to characterize existing pineapple-based farming systems and to evaluate the sustainability of selected farms based on the MESMIS methodology; The third section pertains to methods used to capture farmer's perceptions (e.g. problem trees) and to evaluate overall system performance (SWOT analysis).

2.1 Profiling of the pineapple Industry

As mentioned in the introduction the emphasis of the research is in the North Huetar Region (RHN) of Costa Rica. The profiling of the industry was based on a compilation of different literature sources including several articles and journals. In addition during the period July 2013 throughout May 2014 I engaged in a continuous dialogue with different actors during meetings, interviews and gatherings. These included the following events:

I) Participated in the Symposia "Pineapple activity in Costa Rica: an integrated approach" Symposium facilitated by UTN (Universidad Técnica Nacional) on the 6 th of September 2013. Several actors of the pineapple sector including producers, governmental agencies, universities, community members near pineapple plantations and private enterprises attended the symposium. The main topics addressed during the meeting including the current situation of pineapple in Costa Rica, Environmental and Social problems associated with pineapple systems, and visions of local Universities on this industry.

II) Attended monthly meetings of the National Platform of Responsible Pineapple production of Costa Rica. This platform is a subsidiary of the MAG and aims to promote the participation of actors linked to the pineapple production in a continuous dialogue. They seek to build proposals towards improving production schemes, relationships with communities, workers and the environment. This actor played an essential role in guidance through the implementation of the methodology and activities included monthly meetings with Jairo Serna.

III) Engaged in meetings with Cooperatives members of Coopepiagua and Coopepiña among which administrators and producers gathered to discuss current events.

IV) Coordinated and attended the ""Sustainable Pineapple sourcing workshop" held on 30th of April 2014 at the Instituto tecnológico de Costa Rica, in Santa Clara.

Through attending these activities and meetings allowed me to have many conversations with key actors within the sector. This helped me to gain a better understanding of underlying processes and obtain invaluable insights that were used for the profiling of the pineapple sector.

2.2 Diversity of farming systems

2.2.1 Farm typology

The term farm typology refers to a methodology for defining key characteristics of a select group of producers from a same region. In the case of this study the methodology implemented is "experts knowledge" by which can define concrete areas and are based on skill knowledge by agricultural experts, local governments and the state. (Madry, 2013) This helps to analyze a complex reality such as diverse producer communities by grouping farmers into clusters of farms that resemble each other in terms of key differentiating traits. These typologies can be a useful tool for advisors or project managers, which need to diagnose farm functions, to train and advise farmers in terms of technical, environmental and economical choices. However, in this context it is important that recommendations may be farm-type specific for different types of farms. So in order to better address the needs of specific groups certain variables should be chosen to differentiate these groups by developing surveys to gather such information (Landais, 1998).

2.2.1.1 Questionnaire used to develop farm typology

Based on a paper by Tittonell et al (2010) the following checklist was elaborated to have a guideline to generate the surveys in order to collect the information regarding the farming system and farmer characteristics. From this, the questionnaire was elaborated, and from the questionnaire results variables were chosen to develop the farm typology with this list being shown in Table 3.

General Information
Region
Total farm size owned by the household (ha)
Total area with cash crops (ha)
Age of household head
Name of household head

Farming System
Key activities (animal and crop)
Total number of livestock
Type of production (Organic/Conventional)
Crop diversification (# of Crops)

Yield (ton/ha)
External dependence: Input Use (Regular Scheme of Applications)
External or internal Resource use (On-farm generation of inputs)
Assets available (machinery, buildings, etc.)
Planting Densities of Pineapple

Economic parameters
Production costs
Profit per kg of pineapple

Socio-Cultural information
Family labor (# of member working)
Gender Roles in the farm
Access to Knowledge

Key constraints listed by farmers
Economic Stability
Marketing Constraints
Production Constraints
(Adapted from Tittonell et al , 2010)

According to the checklist above the questionnaire was elaborated to adapt to the different sized farms. (See Appendix 2, for the questionnaire used when interviewing producers)

2.2.1.2 Farm Surveys

The selected farms are based in the Region Huetar Norte (RHN). This choice because most of the small farmers, that are the most severely impacted by the marginalization of the pineapple production chain, are located in RHN. An existent database from MAG, provided by Jairo Serna the manager of "Plataform de Piña" (Pineapple Platform), was used to select and contact different farmers. In terms of selection criteria large, medium and small farms were selected from the list. These categories correspond to a farm size of < 50 ha, 50-250 and > 250 ha, respectively. It was also essential to include some organic farmers from different farm type categories that broadly may be categorized as individual producers, companies and cooperative members.

The survey was carried out during a farm visit. The visits constituted a summary of the study objectives and purpose, followed with the questionnaire in Annex 2. Surveys lasted around 30 – 40 minutes approximately per farmer. The visit concluded with a walk through the farm to get a general impression of the infrastructure and land holdings. The producer gave a tour explaining their production scheme, problems, and practices along with other relevant information that may be useful for developing a farm typology later on.

Thirty-six farmers were interviewed and the distribution of the types of farmers interviewed is presented in Table 2. In total 6 farmers were organic while 30 were conventional.

Table 2. Producers visited for responding farm surveys and interviews.

Producers	Organic	Conventional	Total
Small (1-50 ha)	4	25	29
Medium (50-250 ha)	1	4	5
Big (> 250 ha)	1	1	2
Total	6	30	36

2.2.1.3 Multivariate Correspondence Analysis (MCA)

For the statistical analysis of the variables program R version 3.03 and package ADE4 (R Development Core Team, 2012) were used. Because of the large number of qualitative variables, which prevented use of standard Principal Component Analysis, therefore an MCA (Multiple Correspondence Analysis) was used instead. This method constructs axes of principal components summarizing the variables used into a set of categorical variables. MCA allows analyzing the correlations and associations between farmer's characteristics to be displaced graphically in the results (Factorial Correspondence Analysis). It uses two- dimensional graphs, plotting components against one other within a set of axes; categories of the variables are located in the center of the axes (Guinot et al, 2001). During the data analysis, collected information had to be processed in distinct subsequent steps to warrant a homogeneous data set.

2.2.1.4 Data compilation

Entering values into Excel sheets proceeded the questionnaires, and a total of 25 quantitative and qualitative variables were generated. However, certain variables were left out of the analysis, and a ranking of the data was premeditated according to the objectives (Table 3). The data had to be sorted out in order to be transferred to the program. Combination of certain variables was created, after which original variables were dropped to make data comparable resulting in a total of nine quantitative and ten qualitative parameters. These were then ranked in terms of their relative importance as related to perspective farm types (Table 3).

Total fixed labor = Family labor + fixed labor

Cultivated ratio = cultivated pineapple area/total farm area

Table 3. Ranking of Qualitative and Quantitative data to sort variables to include in MCA Analysis.

Quantitative Data	**Qualitative Data**
Pineapple acreage	Organic/Conventional
Total farm Size	Type of production
Production cost/ha	Access to packing station
Price/kg	On-farm composting
Planting density (plants/ha)	Crop rotation
Number of permanent workers	Machinery
Family labor number	Temporal workers
Cattle heads	Access to Credit
Age of the head of the household	Land tenure
	Use of soil testing

2.2.1.5 Data conversion

An HC (Hierarchical Clustering) method was used to transform the quantitative variables to qualitative ones. This method is commonly used to categorize farmers or farmer practices into classes/modalities (Table 4) but it may also be used to convert quantitative data to qualitative data (e.g. small, medium and big). During this process a HC was performed per variable to gradually group variables according to farmers resemblance, measured through an index of dissimilarity. The pairs therefore obtained are then aggregated using the Wards minimum variance method. It was applied to generate a segregation of different classes for a specific variable. Through a dendogram the classes were separated by using the cut tree method (values are being separating based on a set level of dissimilarity).

Certain checks and modifications had to be done to ensure a sound equilibrium in the analysis (e.g. to prevent single very large farms to bias to overall analysis). This implied that certain farms that had a disproportionately great loading in any of the axis in the MCA, had to be removed in order to prevent it to obscure mare subtle characteristics differentiating the remaining farms. Farms that were disproportionally different (e.g. outliers) from the overall farm population were taken out (2 big farms). This cluster was obviously defined before the actual analysis so it was not necessary to keep them. Also certain variables/practices (management and production type) were dropped from the analysis because they were also pulling the individuals to an axis making observation falling in fuzzy boundaries between groups. This is done for the overall clustering to be as objective as possible (Blazy, 2009).

This exploration process was repeated to ensure that the analysis was both objective and coherent in terms of results being plausible. Table 4 provides an outline of the variables along with the code used during subsequent clustering and MCA analysis, together with the number of classes, corresponding descriptions and number of farmers in each class.

Table 4. Description of the variables and classes created for the typology and farms distribution.

Variables	Code Variables	N° Classes	Description Modality	Number of farms
Total Farm Size	TotLandQ	1	90-130	3
		2	70-50	5
		3	30-20	7
		4	1-20	13
Cultivated Ratio= Cultivated land/Total Farm Size	CultiRatioQ	1	1	7
		2	0.50-0.85	7
		3	0.25-0.50	9
		4	>0.2	5
Total Fix Labor = Permanent Workers+ Family Members Working	TotFixLabor	1	<24	2
		2	9-12	4
		3	5-6	5
		4	4-3	14
		5	1-2	5
Family Members Working on Farm= Family Labor/Total Fix Labor	FamRatioQ	1	1	17
		2	0.6-0.8	2
		3	0.2-0.3	4
		4	0.0-0.2	5
Temporal Labor	NoTempLabor	1	Yes	25
	TempLabor	2	No	3
Planting Density	DensityQ	1	<65000	3
		2	60000	16
		3	55000	3
		4	>50000	6
Price paid	PriceQ	1	0.44- 0.50	3
		2	0.27-0.36	17
		3	0.20-0.25	8
Cattle Heads	CattleQ	1	40-70	6
		2	10-30 <	4
		3	0-3	16
Crop Rotation	No-rotat	1	No	15
	Rotat	2	Yes	13
Produces own fertilizers	Non-fertil	1	No	24
	Fert	2	Yes	4

2.2.1.6 Cluster analysis

After the successful transformation of variables and data-screening, individual farms are then grouped into farm types using Agglomerative Hierarchal clustering (AHC) algorithm, in which the MCA is being used as input variable. The HC was conducted with the first factors obtained from the MCA. This procedure is to calculate the level of similarity between producers of RHN in order to generate clusters based on their shared characteristics. The HC used the Ward method for linkage calculation.

Some farms were identified in order to make a comparison of different systems (organic vs. conventional and organic big vs. small). These farms were taken through the rest of the methodology (sustainability indicators and SWOT analysis) to make an in depth analysis of their farm performance.

2.2.2 Sustainability Assessment (MESMIS Analysis)

During the last decades increased emphasis has been placed on enhancing the sustainability of agricultural systems. There is a need for developing tools that allow assessment of sustainability via quantitative approaches so systems can be compared and overall systems performance be monitored over time. Eventually leading to a re-design of the systems. Assessment of farm performance in terms of relevant sustainability indicators often is ill defined since it is a very complex concept. Therefore there is no clear consensus among researchers on definitions of sustainability in general and there is a lack of universally accepted methods for assessing sustainability (Hayati et al 2011) A sustainability evaluation framework facilitates the formulation of actions plans for improving the management of different systems as part of an exploration of viable alternatives during the re-designing of farming systems (Lopez-Ridaura et al 2000).

The Indicator-based Framework for Evaluating the Sustainability of Natural Resource Management Systems (MESMIS, the Spanish acronym) was developed to assess sustainability in specific agricultural and forestry systems, by integrating environmental, economic and social aspects, in a participatory and interdisciplinary way, through comparison of systems at one point in time or over time (López-Ridaura et al., 2002). The MESMIS framework was developed in Mexico and later used in other parts of the world. This is a methodological tool to evaluate the sustainability of NRM systems. It is a methodology that integrates key concepts towards assessing concepts like including sustainability of NRM (natural resource management) defined by 7 attributes: productivity, stability, reliability, resilience, adaptability, equity and self-reliance. The assessment is valid for management systems in a given geographical location and it is a participatory process requiring an interdisciplinary evaluation team. Sustainability is not numerically measured per se, but it does so by comparing two or more systems (Lopez-Ridaura et al 2000).

This methodological framework has been widely used in the last fifteen years for assessing the sustainability, and it has also served as a tool in decision making in agricultural, livestock, forestry, and agroforestry systems, both subsistence and commercial levels (Speelman et al., 2007).

To assess the farms performance several tools were used, like participatory approach techniques to extract information from producers and stakeholders. Also techniques like MESMIS to analyze from performance of use of Natural Resource Management (NRM) systems using sustainably indicators. This section attempts to gather information from economical, production and social function of the farming system.

In the context of this thesis the MESMIS (Spanish acronym for Indicator-based Sustainability Assessment Framework) analysis was carried out using indicators for selected farms. Sustainability attributes and corresponding criteria, indicators, methods and critical points are outlined in Table 5.

Table 5. Sustainability Indicators for assessing three selected farms in RHN region based on sustainability attributes, diagnostic criteria and corresponding indicators, methods and critical points that were used to generate spider diagrams to visually depict system performance for different farm types (adapted from Dogliotti et al, 2013).

Sustainability Attribute	**Diagnosistic Criterion**	**Indicator**	**Calculation Method**	**Sustainability Dimension**	**Critical Points**
Productivity	Production and economic efficiency	Yield of main crops	Actual Yield /Attainable yield [a]	Bio-physical	Low crop yields
		Production Cost	Total Cost= labor+ input+ materials +activities + others	Economic	High costs for commercial system adoption
Stability	Soil Quality	pH	Soil Analysis	Bio-physical	Soil Degradation
	Natural Resource Preservation	OM [b] aggregated		Bio-physical	
		Erosion Level	RUSLE Model	Bio-physical	High risk of erosion
Resilience Adaptability and reliability	System Diversity	Crop Diversification	Linkert Scale [c]	Bio-physical	Monocropping dominance
	Profit Share	Social Programs and worker benefits.		Social	Low social equity
Self-Reliance	Input dependency	External Dependence	Linkert Scale	Economic	Failure of technological packages
		External/total inputs		Economic	

[a] The attainable yields was defined by the farms managers based on expert knowledge on yields based on edaclimatic conditions and prevailing production practices.

[b] Each organic farmer applies organic matter (OM) either as compost, legume residue or other organic forms to each field. The farmers expressed values as quintal (46 kg) which were then converted to ton/ha.

[c] Linkert scale: assessment of either positive or negative response to a statement (Linkert, 1932)

Certain farming practices were measured using the Likert Scale as shown in Table 6. It includes crop rotation/diversity, profit share (worker rights) and external dependence (commercial companies, nutrient exportation from other farms), to make them comparable for the analysis. Standard literature sources and expert knowledge (stakeholders) were used to adopt a scoring table for different agricultural practices (Adapted from Waney, et al., 2013)

The aim was to select key criteria and develop a simple scoring methodology to assess the impact of these different farming practices on specific sustainability attributes. A score of 1 to 5 was being used to assess different practices as being more or less sustainable. A very low score (1) is associated with practices that result in poor performance while 5 being the highest possible score, which is indicative of optimal farm performance for a specific sustainability indicator. A more detailed description of ratings is provided in Table 6.

Table 6. Outline of scoring graduation employed while assessing sustainability Indicators for social and environmental factors, which could not be quantified directly (Adapted from Waney, et al., 2014)

Indicators	Score 1	Score 2	Score 3	Score 4	Score 5
Crop Rotation	No crop rotation at all. Monoculture with no rest.	Rotation with 1 crop, fallow or leguminous crop (resting lots).	Rotation with more than one crop.	Utilizes rotation with strategic planning between different families and leguminous plants to return soil nutrient loss.	Utilizes rotation with strategic planning between different families and leguminous plants to return soil nutrient loss. Intercrops with fruit tress, annual and perennial crops.
Farm self sufficiency/ External Dependence	Uses synthetic fertilizers and pesticides. Regular preventive applications.	Use the minimum chemical fertilizers Use other techniques like microorganisms and organic agriculture approved inputs.	Uses approved organic agriculture inputs. Natural Pest Control. Natural Permitted Fertilizers	Purchase manure and ingredients to create compost (rock phosphate, blood meal, etc.). Also purchases other natural pesticides or microorganisms.	Utilizes in farm manure and crop residue to create compost and other farm fertilizers or natural pesticides (Bordeaux mixture, Biological Control, etc.)
Profit share- farm workers	Only temporary workers, usually illegally and usually low salaries.	Minimum salary payment and no social security- temporary workers hired.	Fixed Workers, social security payments.	Family based farms, subsidized work with own labor. But the whole family lives from the farm (income and food)	Social community programs. Special certifications with price premiums for social wellness programs. Includes

programs like fair trade certification and Global Gap.

Three farms were selected and follow up interviews were used to generate the required sustainability parameter using the methodology discussed above. Selection criteria included availability of reliable production records and it was also decided to contrast organic vs. conventional systems and farm size. Within organic systems small farm targeting local markets were compared to large farm exclusively focusing on export production. Both farms 2 and 3 are in the cluster of big farmers. This was unfortunately but those were the only farms with enough information to carry the MESMIS analysis. See Table 7.

Table 7. Farms selected for assessment of farm performance analysis.

Farms	Hectares	Cluster	Market Orientation
Nº 1, Organic	20	2	Local Market
Nº 2, Organic	395	1	Export Market
Nº 3, Conventional	241	1	Export Market

2.3 Global system performance and participatory methods

2.3.1 SWOT Analysis

A SWOT analysis was included to complement the farm typology. In this context, a SWOT analysis was implemented for specific farm groups. The SWOT analysis was based on information obtained during from farm surveys, interviews, and workshops and this information was complemented by a literature review.

First the internal factors (strengths and weaknesses) and external factors (opportunities and threats) of selected farm types were identified. This analysis helped to integrate and synthesize information, to communicate it to stakeholders and helped to structure appropriate strategies for targeted groups of farmers.

2.3.2 Participatory System Evaluation Techniques.

Participatory methods allow for more effective utilization of local knowledge and afford farmers and actors of the sector to actively contribute to the generation of knowledge and sharing of information. This may improve end-user engagement, relevance, and ownership of proposed innovations. During the course of this thesis two tools were being employed to contribute to this process: (1) problem trees and (2) workshop.

2.3.2.1 Problem Tree Development and Evaluation

Active participation of farmers and a continuous dialogue among stakeholders is essential both during the problem identification (problem tree development) and as well while exploring and structuring solutions. Throughout this process this technique will be explored with input of the different actors actively solicited.

The problem tree was developed in three stages:

Diagnose/ Identification

The surveys and interviews greatly contributed during the identification of farm-specific and more universal problems for the different farm types. During the interviews farmers articulated their specific problems, and ranked them during the interview and were also encouraged to describe sequence of events linking different aspects .

Draw/ Analysis and Elaboration of trees

A visualization and analysis of the problems by mapping the linkage by different causal agents and consequences (problem tree) was made in order to assist the analysis and clarification of cause-effect relations. The trees were made together while visiting with the farmers. The initial conceptualized versions were then revised to meet a standard format (causal factors at the bottom and consequences at the top with the farm operation being in the middle) and presented to the representatives of the sector during the workshops. The objective was to get their active input and revise the diagrams accordingly. This process is a spiral process in which there is always new input and changes of external factors. As a result, the understanding and interpretation of governing factors continuous to evolve for any specific farm operation.

Dialogue

During the workshop together with stakeholders and farmers the trees were discussed to validate the problem trees. During the workshop a blank paper with the 3 problems trees presented in the results were handed to all 20 stakeholders present. At the end of the workshop the papers were collected with comments from all stakeholders (See Fig. 5).

This helped to determine the root causes of the main problems and corresponding consequences while also map possible solutions. In this manner it complemented and reinforced the results from the farm typology since it allowed the targeting of specific farm types rather then using a "one-size fits all" type of problem solving approach. After the stage of analyzing all the information gathered during the interviews and surveys, the formulation of problem trees has three main parts: problems, causes and effects. Participatory discussion tables are essential to achieve solutions to the main problems that want to be addressed in the new farm designs and feedback for changes or differences of opinions (S. Dogliotti, 2013)

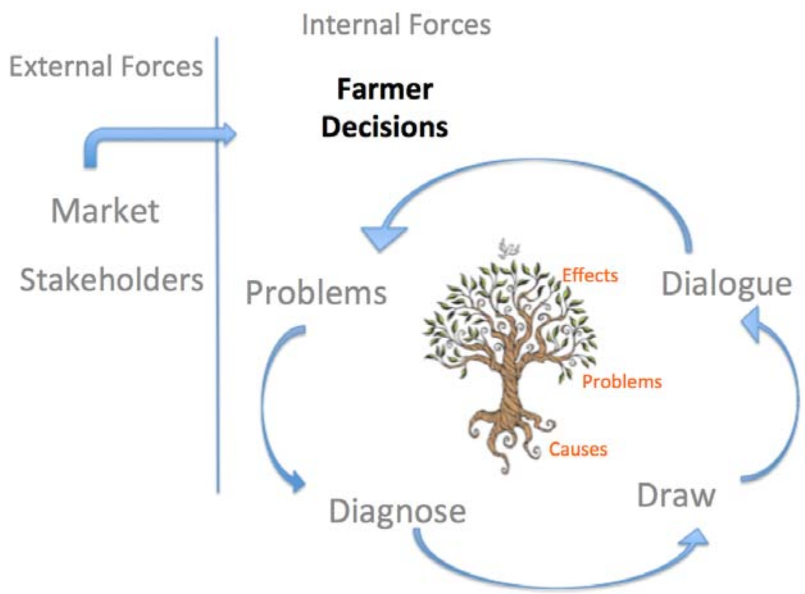

Figure 6. Problem Tree Diagram Methodology.

2.3.2.2Work Shop

The prime objective of the workshop was to present the preliminary results of the pilot study. The activity took place to discuss certain topics (Table 8) of interest with different actors from the pineapple value chain and the agenda of the workshop is presented in Appendix 2.

In groups of five actors from different areas and expertise, participants discussed for one hour the problem trees and possible solutions and consequences in terms of desirable design of future production systems and/or value chains.

Table 8. Methodology used during the workshop that elucidated the opinion of the different stakeholders within the organic pineapple sector and other key informants and actors (conventional producers, governmental representatives). (Serna,. 2013)

Objective	Methodology	Result
Validation Problem trees	Initial drafts of problem trees were presented using a power point presentation. Then participants would make comments or feedback changes. Subsequently actors were separated into different groups. Hard copies of the problem trees were handed to each person and participants were invited to sketch ideas and improvements to be hand in at the end of the workshop. This activity was followed by discussion pertaining to potential solutions and identification of actors who would be willing to implement these solutions. Each group presented their findings, which was followed by a discussion of the general audience.	Confirmation of effects and underlying causes of problem trees by the stakeholder actors. Improvement and changes to interpret actual situations. Structure solutions in terms of defining how problems may be addressed during are-design phase including development of alternative and more sustainable business models.
Introducing new production designs	Power point presentation of possible future production designs. Two production designs were presented in order to receive feedback from farmers. Each group presented their outcomes followed by a discussion with everyone present.	Feedback from producers and actors on important design features. Which technical requirements and organizational skills are needed for a successful development towards organic production of producers in RHN?
Research needs in organic production	Discussion of future research needs related to organic production that can enhance the sustainability of the overall sector as well.	Essential research topics to improve the pineapple production and other organic crops.

During the field visits and interviews, which was part of the workshop, essential information was also collected and used for constructing the problem trees. During this activity all the actors were able to be more aware of the problems encountered by farmers and integrate this information in their analysis in order to ground-truth pre-conceived notions as part of their analysis and to confirm major causes and consequence.

This method will be continued during new designs and further investigations. Farmers should agree upon issues presented and provide feedback to analyze and propose different viable solutions to solve these problems. Including different actors within the value chain is critical to come up with feasible solutions and to get broader support for potential intervention from the entire sector and throughout the whole value chain. This activity was followed by discussions to address potential obstacles related to production, marketing, commercialization and distribution tactics of the agricultural chain.

Alternative managements practices and production systems designs (based on emerging market niches for tubers and tropical fruits from EOSTA and compatible with current production practices and existing infrastructure) were presented to the producers and other actors. These designs were examples of viable alternatives that are not widely being used yet but may hold promise.

3. Results

3.1 Profiling of the pineapple Industry

To fully understand the pineapple industry a review of important historic events is necessary along with an outline what external and internal forces that shape the industry, which is provided in the following section.

3.1.1 Governmental Policies and traditional crop shifting from the 1950' s-1980's.

Costa Rica has experienced very important socio-economical structural changes during the 1950's-1960's, which ultimately led to changes in the domestic market and an increased shift towards export-oriented agriculture during the 1980's. The political parties at the time implemented wide political strategies to diversify the productive structure of the country. The changes of agriculture in Costa Rica are due to three main factors: (1) the national policy agenda, (2) trade agreements and (3) prevailing external market conditions. During the 1980's Costa Rica was facing a critical economic conditions due to the crisis in Latin Ameria, international oil prices and internal policies which resulted in changes in both internal and external markets and policies (Cartin, 1980).

One of the main preoccupations of policy makers and planning agencies was to develop also those sectors of the economy, which attend to local consumption. The goal in the long run was to be self-sufficient in terms of essential food basket products (corn, rice and beans). However, this objective soon became outdated because of the potential profits from the cultivation of export crops. As a result, self-sufficiency and food sovereignty was no longer being sustained by the different grain producers in Costa Rica as shown in Table 9 (Cartin, 1980).

Table 9. Costa Rica: Basic Grains exterior commerce in 100 TM (annual mean during period 1960-1970) Source: Cartin, 1980

Basic Grains	Import	Export	Balance
Rice	25.18	7.27	-17.91
Corn	69.09	11.81	-57.28
Beans	43.36	1.81	-44.55
Total	140.63	20.89	-119.74

To improve the economic situation the country and trade balance the government started to encourage exports, including agricultural products, by providing substantial subsidies to stimulate the production of non-traditional exports. However, this program was criticized because it mostly benefited larger companies and export operations (Pomerada, 2004).

Regardless clear changes occurred including a sharp increase in the exports of non-traditional crops while production of traditional crops like basic staple crops including rice, maize and beans. These crops are mainly produced by smallholders, which have declined in terms of land use from 39.7% in 1990 to 28.5% in 2000 and this was mirrored by a decrease in production area dedicated to basic grains (Cartin, 1980). Moreover, the elimination of government support of price guarantee programs, jeopardize the existence of small grain producers, which changed crops or opted to pursue off-farm employment in large farms/companies.

3.1.2 Evolution of Market Oriented fruit production in Costa Rica

Costa Rica is known for several export products such as pineapple, coffee and banana. The evolution of the fresh fruit for international and local markets grew very fast. From the 50's to 90's Costa Rica was mostly self-sufficient in terms of agricultural production but over time it has increasingly focused on export commodities while increasingly importing food crops. The ministry of agriculture has separated and grouped the variation of crops in Costa Rica in the following categories: (1) industrial crops, like sugar cane, coffee, orange, macadamia, etc. (2) fresh fruits, (3) tropical roots, (4) horticultural products, (5) basic grains. Most of the agricultural products are for export markets while second and third quality products from the fresh fruits, industrialized crops and tubers may be marketed locally. In contrast, most horticultural products and basic grains are produced for local consumption (MAG, 2010). From Table 10 it is evident that in terms of land area fresh fruit crops are the second largest sector after industrial crops and that between 2000 and 2008 the acreage of fruit crops increased by 22%. This increase was coinciding with a decrease in grain crop acreage by 27%. In term of the acreage of fresh fruit crops, pineapple is the second largest crop and this area increased by a factor three between 2000 and 2008 (Table 11). Moreover, in 2013, it already accounted for 45.000 ha while at the same time the production also is becoming increasingly marginalized.

Table 10. Cultivated Area of the main tropical fruits during 2000-2008 in Costa Rica. (MAG, 2010)

Crop	**Ha**		**Change**
Year	2000	2008	%
Banana	47982	44313	-8
Pineapple	12500	33488	+168
Melon	7185	8640	+20
Plantain	8347	6500	-22
Papaya	619	840	+35
Mango	8200	8500	+4
Strawberry	100	136	+36
Total	84933	102417	+20

The distribution of the different tropical fruits is shown in table 10. This category is the second biggest agricultural industry in Costa Rica, as shown in Table 11.

Table 11. Distribution of ha for the different agricultural industries identified in Costa Rica. (MAG, 2010)

Type of Crop	2000	% Total	2008	% Total
Industrial Crops	239025	53.3	247681	55.2
Fresh Fruit	84933	18.9	103480	23.1
Basic Grains	109399	24.4	80143	17.9
Tubers	9497	2.1	11659	2.6
Horticultural Products	5599	1.2	5622	1.3
Total	**448453**	**100.0**	**448585**	**100.0**

3.1.3 Profiling of the agricultural industry in RHN

3.1.3.1 Description Research Area

Most of the pineapples are produced in the northern part of Costa Rica, in the RHN region (Region Huetar Norte) accounting for 52% of the national pineapple production (Figure 7). In Costa Rica there are around 1300 pineapple farmers from which 1200 are small holders, 95 intermediate and 35 are big farmers. In terms of the entire production area, 35% belongs to trading companies while 65 % are independent producers that might be members of the several cooperatives and associations of small and medium producers (CANAPEP website). Recently this numbers are being questioned by the authorities, with the supposition that the numbers of hectares are being kept the same by big companies, however small producers are loosing their farms to debts and production costs. (Personal Communication with Jairo Serna, October 2013)

RHN is bordered by Nicaragua in the north, Guanacaste and Alajuela in the south and Limon region in the east. The region has a land area of 12,000 km^2 and the predominant soils are Ultisols and Inceptisols. In general the soils have, very poor chemical fertility, are low in base saturation with pH values ranging between 4 and 5.5 while unamended soils may show severe phosphate deficiency. Using the Holdrige classification, the region has a tropical climate (Holdrige, 1947), with a single rainy season from May to January/February. The dry season lasts from March to May. Average cumulative annual precipitation varies greatly with values from 2.000 mm yr^{-1} in the plains with corresponding average annual temperatures of around 26 °C up to 5.000 mm yr^{-1} in the volcanic areas. In this zone average temperatures are 20° C, the relative humidity is much higher (80-90%) while due to high cloud cover the average hours of sunshine is only 3-5 hours daily.

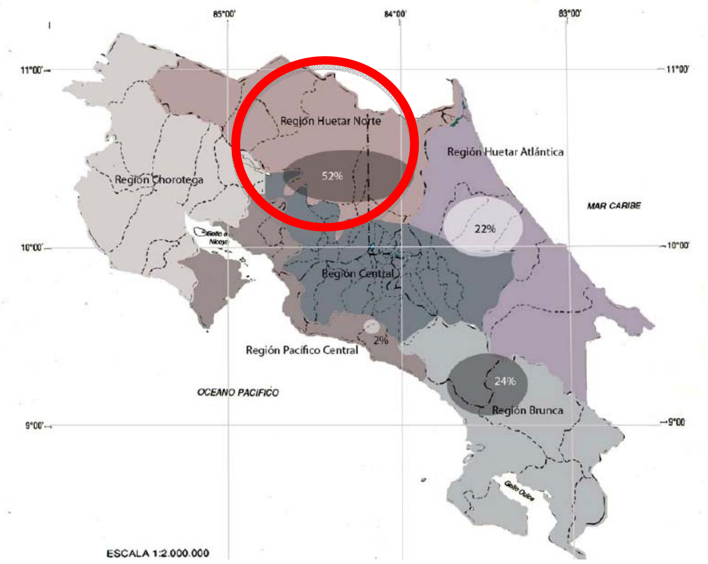

Figure 7. Regional distribution of pineapple in Costa Rica, the proposed case study is located in Zona Huetar Norte (red circle) Source: Aravena, J. 2005

A study conducted by the UCR (University of Costa Rica) addresses the effect of free trade and governmental policies during the last twenty years in the RHN. The RHN was settled during the course of the last century. During the 1960s and 1970s, national policies promoted family farming (family-based settlements) to serve the internal market and assuring food security. Since the 1980's, the state started implementing national policies and reduced its support for production for the national market, and started to support non-traditional export crops, which was called "agricultura de cambio" (agriculture of change) (Samper, 2004). This led to the development of a "dual economy", in which an export sector with large foreign capital coexists with a national industry with low dynamism and reduced competitiveness (Ramirez, 2007). Some of the traditional crops in the area included grains, sugarcane and tropical root crops, which provide around half of the jobs in the region taking in to account also livestock farming (cattle, dairy and pig production). Non-traditional products include crops such as citrus, macadamia, and pineapple among others. In 2007 only six commodities accounted for 90 % of the total production of agricultural land in this region the main crops are pineapples, orange, cassava, sugar cane, heart palm and basic grains. In recent years the tourism industry has emerged as a viable alternative. The rapid expansion of the pineapple industry has affected the livestock industry most severely (PROCOMER, 2008). A large fraction of products was exported with the main export products being pineapple, juices/fruit concentrates, tropical roots and ornamental plants.

In addition to being an important for export crops, this region is also facing serious erosion problems in the more mountainous parts. It is the result of poor agricultural practices, high deforestation and lack of knowledge on suitable conservation practices of the local farm communities. The current growth in pineapple production has resulted in a shift from more agroforestry-based systems to unshaded monocropping systems. This has resulted in environmental perturbances triggering soil degradation, surface water contaminations and problems with solid waste management. In recent years public institutes, private enterprises, municipalities and international NGO's have been trying to develop soil conservation measures and reverse the degradation of natural resources.

Based on field observations it is evident that producers cannot abandon their current high input and tillage production systems instantaneously and also need adequate support while adapting different production techniques. As an example the conversion of conventional to organic, requires better management skills, different inputs while farmers need to comply with certification standards and maintain a record keeping system. Moreover, the transition is three years. Furthermore, in terms of organizational and operational components farmers face many challenges including logistics, quality control, and storage facilities; having access to proper marketing channels gaps. Finally solutions should be placed in the context of resource endowment, resource management, capacity building, and market access

In the context of mapping local farming systems it is relevant to look at some basic farm types including farming styles and/or strategies, farm activities, farm scale, and performance assessment criteria. In Table 12 a basic typology of the prevailing farm types in the RHN region is provided along with their strategies, assets and evaluation criteria (critical points). From this table it may be concluded that the different farmers have implemented many different strategies. Some of them focus in exports markets or in renovation of diverse farming systems. Some have continued with the same crops produced in the area like meat and dairy farms. This table highlights and allows a preview of the high diversity of farmers in the area and how they have found different ways to sustain their farms with different activities.

Table 12. Characterization of farms in the RHN in relation to their strategy. Source: Faure, 2004

Strategy	Export		Modernization		Renovation	Permanence		Defensive	
	No relation with structure for export	Relation with structure for export	Cattle/ Crops	Milk	Diversified Farming System	Sugar Cane	Lives-tock Meat/ Milk	Extensive Cattle	Settlements that face difficulties
No. of Producers	2000	1500	2000	1500	1000	1000	3500	1500	4000
Surface/exploitation (ha)	1 to 30	2 to 30	50 to 300	10 to 50	5 to 30	3 to 100	10 to 50	50 to 500	5 to 20
Advantages			Financial Capacity a/ Risk distribution	Income stability	Technical knowledge/ Autonomy b/ Risk distribution	Income stability/	Autonomy/ Low production Costs	Autonomy/ Low production Costs	Mobility
Critical Points	Production Costs / Norms/ Weak organization	Production Cost / Norms	Production Costs/ Unattractive prices	Production Costs	Technics to be improved/ Organization / Modest income	Production Cost/ Low productivity	Modest Income	Low productivity	Low investment Capacity

a Have enough income to invest in innovation and modernizations of their farms.

b Means they depend less in intermediaries to commercialize their products and they depend on local consumers and markets.

National policies provided incentives (e.g. subsidies) to farmers to specialize and intensify their farm operations. This led to increased production, therefore increased dependence on expensive technologies, like imported agrochemicals, machinery, and fossil-fuel consumption. Pineapple is a relatively intensive crop in terms of agro-chemical inputs as shown in Table 13. (Ingswere, 2012). In this context, large companies and international markets were governing prevailing production practices while also controlling external distribution (Faure , 2002 and Aravena, 2005).

Table 13. Summary of pineapple data. Use of energy inputs (pesticides, fertilizers and fuel consumption). Source: Ingswere, 2012

Category	Item	Unit	Avg	SD
Product	Yield	kg/ha/harvest	95358	18020
	Harvest frequency	harvests/yr	0.6	0.1
	Annual yield	kg/ha/yr	57506	2078
	Pineapple mass	kg/pineapple	1.7	0.10
Fuel	Diesel	kg/ha/yr	440	149
	Gasoline	kg/ha/yr	37.4	33.2
Fertilizer	N	kg/ha/yr	401	125
	P	kg/ha/yr	61	59
	K	kg/ha/yr	998	1
	B	kg/ha/yr	3	3
	Ca	kg/ha/yr	15	13
	Fe	kg/ha/yr	6	2
	Mg	kg/ha/yr	35	21
	Zn	kg/ha/yr	6	4
Pesticide	Fungicide	kg/ha/yr	1402	824
	Growth regulators	kg/ha/yr	108	152
	Herbicide	kg/ha/yr	1306	612
	Insecticide	kg/ha/yr	128	17
	Nematicide	kg/ha/yr	283	219

In order to be competitive and to adapt to global markets producers in RHN focused their production schemes on a small number of commodities that mainly targeted export markets for pineapples, ornamental plants, cassava, and oranges (Table 14).

Table 14. Surface (ha) of new export crops in 5 municipalities of RHN in 2000. (Source: Faure, 2004)

Crop	**Guatuso**	**Upala**	**SanCarlos**	**Los Chiles**	**Sarapiqui**	**Total**
Cassava	150	90	3940	600	350	5130
Other tubers	140	440	560	940	240	2320
Plantain	80	290	520	0	290	1180
Pineapple	180	30	3300	0	1500	5010
Heart of Palm	60	1520	1270	0	4310	7160
Orange	20	900	1390	11000	0	13310
Cashew	0	1180	10	0	0	1190
Ornamental Plants	0	0	660	10	180	850
TOTAL	630	4450	11650	12540	6870	36150
% export crops/export crop + traditional crops	62	76	52	44	96	56

Table 15. Distribution of cultivated land between families based systems and companies in 2004. (Source: SEPSA, Regional Survey of fruits and tropical roots, 2005, UNICERSE 2004).

Type of producer	**Tubers**		**Basic Grains**		**Pineapple**		**Orange**		**Sugar Cane**		**Others**		**Total**	
	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Family Farms	6000	75	15000	94	1500	14	500	3	3000	50	7000	78	33000	49
International and national companies	2000	25	1000	6	9500	86	16500	97	3000	50	2000	22	34000	51
Total	8000	100	16000	100	11000	100	17000	100	6000	100	9000	1000	67000	100

As a result, agriculture evolved rapidly in this area and this triggered various transformations in the farms of the area. Bigger producers, usually cattle farmers, which converted to agricultural production, planted most of these new crops. Mainly this happened with investment offered by international companies (USA/ Europe/ Mexican/ Colombian).

The contrast between different sizes of farms (small vs. big) and their share in the different commodities is shown in Table 15. It is evident from this table that family farmers only account for a very small share of the pineapple business (5%) compared to industrial farms (27.9%). In this context, Family farms mainly focus on staple crops for family consumption like basic grains (45.5%)or tubers (18.2%). Big companies, on the other hand, focus mainly on export commodities like pineapple (27.9%) and oranges (48.5%), as shown in Table 16.

Table 16. Share of different crops on family and industrialized farms total cropland.

Crops	**% of each crop on family farms**	**% of each crop on industrial farms**
Tubers	18.2	5.9
Basic grains	45.5	2.9
Pineapple	4.5	27.9
Orange	1.5	48.5
Sugar cane	9.1	8.8
Others	21.2	5.9

Due to the rapid expansion of pineapple production other agricultural activities were being deemphasized and often abandoned. Certain farmers in the area continued producing commodities for the national market (beef, beans, milk, among others) (Acuña, G. 2006). For example the number of milk cattle farms in the area in 1984 accounted for 34500 producers while in 2000 it had declined to 15100. Some farmers simply stopped farming where as others started cultivating pineapple, like was the case for majority of producers in the south of the RHN region (Faure, 2004) . In 2011 pineapple was the mayor export product in RHN and it accounted for 66.4 % of the total exports of the region (Calderon,2013).

3.1.4 Evolution of pineapple farms in Costa Rica

3.1.4.1 Historic perspective

The plantings of pineapple for international markets was initiated in the 1960's with certain governmental policies as explained in the first section. The Chiquita company promoted and planted the variety Montelirio for export to compete with existing farms in Hawaii, and was the first exporter at that time. Afterwards, the variety smooth cayenne Hawaiian was planted, but due to the lack of technology the fruit did not produce as expected. Ultimately the crop was abandoned for export and only cultivated for the national markets.

3.1.4.2 Agronomic practices

Traditionally pineapple was produced in a natural way (no agrochemical) and it did not require any technological package. During the 1970's the Pineapple Development Company (PINDECO) start operating in Costa Rica and this company initiated operations in the southern part of the country. By the 1980's (90%) of the production occurred in the southern part of Costa Rica while in he Northern part less then 10% was produced. But PINDECO also started promoting production in different regions of the country as well by introducing new production techniques and technological packages. But the biggest expansion of pineapple started when the company introduced the hybrid MD-2 which was adapted to the local climatic conditions. This fruit became the most wanted because of its level of sweetness (Brix degrees)(Peña, 2011) Since the 1980's standard technological package have been introduced including selected varieties suitable for export and introducing unknown machinery in the country. This increased production but also augmented the dependency on production technology and inputs imported from the USA. This technological package was adapted from industrial plantations in Hawaii, where agroecological, topographic, pedoclimatic and socio-economic conditions are completely different from those in Costa Rica. As a result, the planting techniques, density, fertilization schemes, application of agrochemicals, cycle, etc., were completely different from the traditional methods used by local Campesinos. Regardless, the new variety adapted very well to the soils and climate in the country and Costa Rica became the largest producer of export fresh pineapple in the world

(Quijandria, 1997). It may be noted that the industry has evolved in many different ways. A concise overview of the agronomic practices and key features of the key producers is provided in Table 12.

3.1.4.3 Local industry and transnational companies

Global forces and national policies thus shaped the development pathway of agriculture in Costa Rica. The pineapple industry in the 80's rapidly grew by active involvement of large companies like PINDECO, while demand for this fruit kept growing in the USA and Europe. Currently, pineapple is the number one agriculture product exported to the European Union. It accounts for 347.5 million dollars (20.7%) of total exports and in 2011, 375.9 million dollars (19.9%) (Calderon, 2013). This allowed and enticed more and more producers to produce pineapple to meet this demand. So even small family farms started to participate in global production due to the high price being paid in the beginning of 2000's. However, in 2006 it was estimated that PINDECO controlled 50 % of the total pineapple area in the country (approximately 15000 ha)(Acuña, 2006). PINDECO also started to gather independent farmers with an arrangement known as "satellite farming" in which the farmers provide their land and labor while the company supplies the technology and machinery, and also is guaranteeing the purchase of the fruit.

3.1.4.4 Economic realities of local (small-holder) farmers

Since so many producers started producing pineapple, especially small farmers are facing problems to be competitive since they cannot effectively compete with large cooperative farms, which have the required infrastructure and benefit of economies of scale to produce and export pineapple, which is becoming increasingly marginalized. This due to increasing production costs, lower prices and challenges associated with marketing logistics, which will be discussed in more detail below. The success of family-based farms thus depends on several factors such as economic and production conditions. The economic performance of pineapple producers is may differ among different farm types depending on several characteristics and circumstances (farm structure, size, biodiversity, financial capacity, and access to knowledge, technologies, markets among others). Besides these, the objectives of the farmers are known to vary as well, as shown in Table 12 (Faure, 2002).

Producers are also affected by the exchange rate of Costa Rican currency (colon) compared to the dollar, as product prices are negotiated in dollars even though producers have all their cost in Costa Rican Colones. Especially small holders are facing challenges due to the high cost of establishing 1 ha of MD2 pineapple and the 2-year cycle of this crop. This requires high investments, external loans and prevents small producers from have short-term income while they are increasingly dependent on income from pineapple to feed their families. Moreover, in most of the cases initial crop performance may not be optimal while initial costs are very high, therefore only after 3 to 4 years producers start making profits. Besides this, production costs keep increasing. In 2007 it was calculated that inputs costs like transport, mechanization and fertilization had increased as is shown in Table 17. In 2005 the value per kg paid to conventional farmers was on average $ 0.42 of delivered fruit at the packing station. Since this time prices are no longer stable and around 2007 dropped to $ 0.30 or less while currently they range from $ 0.25 to $ 0.17 depending on the size of the pineapple. (Villegas, et al., 2007 and farmer interviews). The former president of CANAPEP[2] also stated in an interview that small producers, which sell to intermediaries, are the most vulnerable to the price fluctuations. Packing stations and trading companies can reject fruit very easily arguing different problems with the fruit (brix, translucently, burned fruit, crown problems, etc.). Since pest problems keep increasing, producers have no other choice but to apply pesticides more often. All these aspects are major threats, which reduce both profitability of the industry and have marginalized pineapple production as compared to the early 2000´s when it was still to be a very lucrative crop (Villegas, O. et al., 2007 and CANAPEP)

Table 17. Examples of the raise of prices of different activities or inputs in the pineapple industry. Source: El Financiero News paper, Costa Rica.

Activity-Input	Cost $ Before	Cost $ in 2012	Difference in $
Exporting 1 box of 12 kg.	2.50	3.25	0.75
Quintal (46kg) of Urea	18	40	22

Since so many small producers entered the business of pineapple several attempts to organize and support producers have been initiated with the help of private companies or donations, as was the case of Proagroin. The Netherlands ministry of foreign affairs funded this program initiated in 1997. ProAgroin is an example of a private foundation that aims to support small producers. It offered producers "credits to plant pineapple, technical assistance, training and commercialization within a social, ecological and economically sustainable framework" mission stated by the foundation. In the next section, it's functioning and limitations are being discussed.

During the beginning of the Proagroin program seemed like a perfect fit due to the benefits it could provide to small producers. For many of them this was seen as a great opportunity to grow and improve their livelihoods. It could benefit them and make a difference in their communities, generating jobs and possibilities for people that did not have the economic capability. However, in practice problems arose when Proagroin did not uphold price agreements. This led to financial problems for those growers who had taken bank loans on the basis of guaranteed prices for their products. In addition, the expected support from advisors never materialized for most farms. At the end the credits kept stacking up for producers until the moment they

[2] (The National Chamber of Pineapple Producers and Exporters - CANAPEP, is a private, legal and nonprofit founded in 2003 to bring together the pineapple producers and exporters across the country)

went bankrupt (Information from producers interviewed and stakeholders insights). In 2013 the Costa Rican mass media MAG announced the bankruptcy of 450 producers, which were part of this foundation (Teletica, 2013) http://www.teletica.com/Noticias/5108-Asamblea-Legislativa-investigara-a-Proagroin-tras-denuncias-de-cientos-de-pineros.note.aspx.

Table 18. Outline of key agronomic practices, production system features and producer traits for different periods in Costa Rica based on different literature sources and stakeholder interviews.

Production Period	Variety	Price level	Fuel Prices	Planting Density	Production Area	Type of Farms	Main players	Key problems	Production Standars	Market
1960-1980s	Monte Lirio/ Criollaab	N.A	N.A	N.A	Home consumption	Small Family	Local farmers	Unknown	None	Localab
1980	Cayena Lisa/ Montelirioab	N.A	Rised	N.A	2000-2500a	Large Scale	Pindeco	Unknown	None	Export/ Localab
1990-1999	Champaka- MD2b	N.A	N.A	20000- 25000b	9900a	Large Scale	Pindeco Proagroin opened in 1997.	Communities start demanding dialogue for environment protection. Phytosanitary problems with presence of weed seeds and pests. b	BPA (Good agricultural practices) b	Local /Export ab
2000	MD2b	0.48- 0.42b	N.A	20000- 40000b	12500	Large Small – Medium	Small - medium Farmers/P INDECO/C hiquita/ Dole	Deforestation Caribbean side Stricter Regulations/ Restriction chemical applications	2005- Global Gap/Fair Trade/ Rain forest alliance/ISOa	Export/ Localab
2008	MD2b	0.35b	Rised	20000- 70000b	45000c	Large Small - Medium	Small - medium Farmers/P INDECO/C hiquita/ Dole	Agrochemicals found in water. Environmental impacts reports conducted. Appearance of Stomoxys calcitrans. Costa Ricans begin to demand for more careful regulation.ac	Demand of certifications of good agricultural practices	Exportab
2013	MD2	0.24		55000- 72000	50000	Large Small - Medium	Small - medium Farmers/P INDECO/C hiquita/ Dole	Producers working with foundations like Proagroin went bankrupt- Demands to different pineapple companies.		Export

[a]Acuña, 2004, [b]MAG ,2007, [c]BANACOL, 2011,[d]Nacione Unidas 2009.

3.1.5 Market requirements, sustainable production and market niches

With the growing global demand for pineapples from Costa Rica and different producers (small-medium and big) entering into the market, international standards for fruit quality were being developed and imposed by buyers during the early 1980's. Currently, producers therefore must comply with the strict requirements of public and private standards for the security and assurance of food quality. This is the consequence of the preoccupation of western consumers related to different scandals connected to food security and market globalization (Trienekens, 2007). In order to comply with international export regulations (Global Gap[3], HACCP[4], ISO, etc.) farming systems had to modify and adapt. Figure 8 illustrates the buyer requirements which are divided into 3 (1) mandatory, legal requirements that all producers must meet to enter in the EU market, (2) common, which means most competitors comply with and (3) niche requirements for specific markets (CBI Market Information Database).

Besides quality certifications it has become common practice for buyers to demand certification to show that producers are implementing sustainable practices. Moreover, in order to be more competitive in global markets some producers opted to find niche markets like organic or fair trade. During the end of 2000's the organic market was booming in Costa Rica and many producers started shifting to organic production. In Costa Rica there are several organic producers although their exact numbers are not known. Production costs for organic pineapple are at least 25% higher comparing to conventional production (Table 19). However, the current price premiums cannot fully cover the high costs. The organic area has been shrinking in the past years since it is not viable for producers. Besides, small producers suffer from the high varying quality of product. In reality, instead of promoting sustainable production practices and protecting organic producers via certification and price premiums, gradually producers stopped receiving price premiums for required certifications. This trend is becoming more and more common and certification is no longer an option but a standard requirement. For example pineapple producers are asked to comply with Global Gap certification and CODEX Alimentarius in order to be considered as suppliers (personal communication Henk Zoutwelle, June, 2014). If nothing else this shows that even organic alternatives so far have provided little in terms of addressing local concerns.

---

[3] G.A.P. stands for **Good Agricultural Practice** – and GLOBALG.A.P. is the **worldwide standard** that assures it. Visit: http://www.globalgap.org/uk_en/

[4] The HACCP stands for Hazard analysis and critical control point system, which is science based and systematic, identifies specific hazards and measures for their control to ensure the safety of food. Visit: http://www.haccpeurope.com/index.php

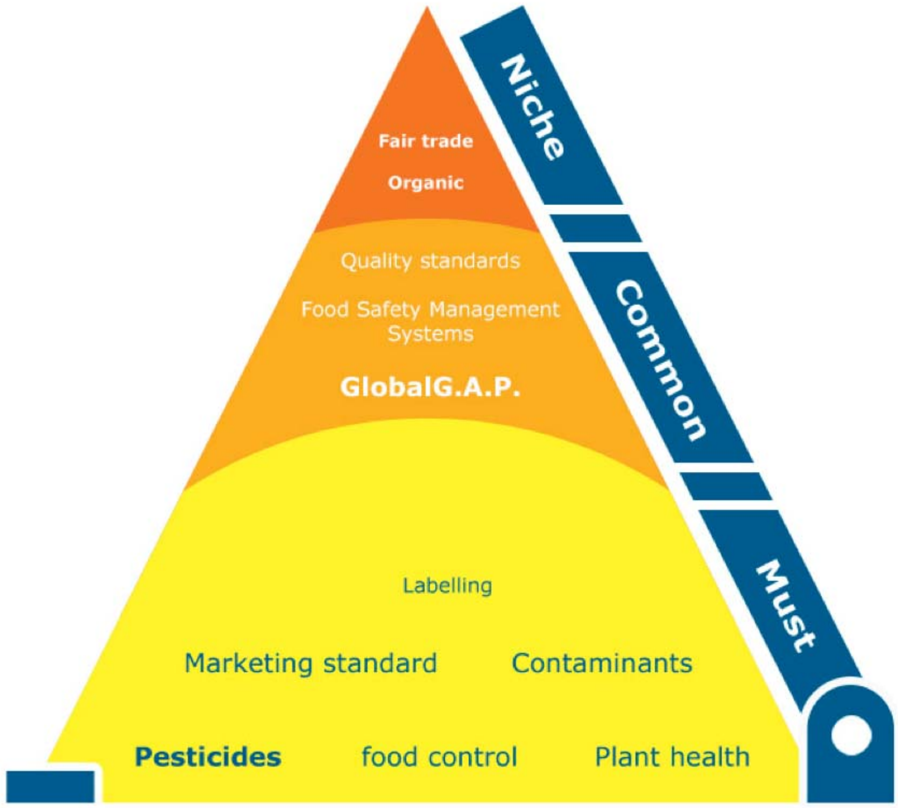

Figure 8. CBI Market Information Database: EU buyer requirements for fresh fruit and vegetables.(http://www.cbi.eu/marketintel_platform/fresh-fruit-vegetables/136122/buyerrequirements)

Table 19. Basic cost of production for conventional and organic pineapple MD-2. (Kellon, D., R. León, and R. Marsh. 2011.)

Component	**Cost ($/ha)**	
	Conventional	**Organic**
Equipment (tillage, spray and harvest)	4,241	4,054
Inputs (fertilizers, pesticides, ripeners, seed)	8,631	15,258
Labor	5,696	4,158
Others (transportation, land rent, etc.)	1,652	1,511
Total	20,220	24,981

Sources: pineapple producers and agrochemical dealers.

3.2 Diversity of pineapple growers in RHN.

3.2.1 Existing farm typologies

Based on existing local studies (Kellon et al. 2011, Faure, 2004 and MAG 2007) the following five types of farmers have been identified in Costa Rica: micro, small, medium, large, transnational producers. An outline of main characteristics of these groups is presented in Table 20. Small-scale farmers are characterized by having smaller sized farms without any packing station for pineapple. These include very small (family-based) farmers (1-2 ha), that sell only in local markets and that are being characterized by producing other crops such as cassava, oranges, sweet potatoes, which are also engaged in animal husbandry (micro-producer). Medium scale farmers are usually bigger in terms of land size and have via commercial companies, access to a packing station as well. Large farmers are cultivating extensive areas and have their own packing station, they are typically associated with international companies, which commercialize and export the pineapple directly to international buyers.(Kellon, 2011). Transnational farms have the biggest land ownership. These include holdings by companies like Del Monte, PINDECO (4000H ha) and Banacol from Chiquita. They manage the entire pineapple value chain until the final destination of the fruit. However, specific characteristics of each type of farmer are not well documented nor are clear how farm size affects production efficiency and sustainability.

Table 20 Characteristics Producers in Costa Rica. (Source: Aravena. 2005, Kellon. 2011 and MAG 2007).

Groups of Producer	Hectares	Yields Conventional	Infrastructure
Micro-producer	> 1	Unknown	No packing station
Small	< 50 (1-10 ha)	Unknown	No packing station
Medium	50-250	Unknown	Access to packing station.
Large	> 250	80 -110 t/ha	Private packing station.
Transnational	Unknown	Unknown	Private packing station.

3.2.2 Farm Typology- Multiple Correspondence Analysis

As mentioned in the methodology a farm typology was performed using Multiple Correspondence Analysis (MCA) on categorical variables. Therefore, the quantitative variables were transformed into categorical variables using Hierarchical Clustering (HC) techniques to obtain classes for the different variables. An example of this is presented in Fig. 9 that shows the four classes obtained were generated for planting density (see Annex 3 for the box plots for other transformed variables). Certain variables, like "*management"* and "*production type",* were not taken into a account for the MCA because some of their classes were under-represented (e.g. only 3 farmers do organic agriculture on the sample retained for the MCA) and the classes overlap with other variables as "priceQ" so they were not included. The general classes and corresponding ranges for the overall modalities used in this analysis are being outlined in Table 21.

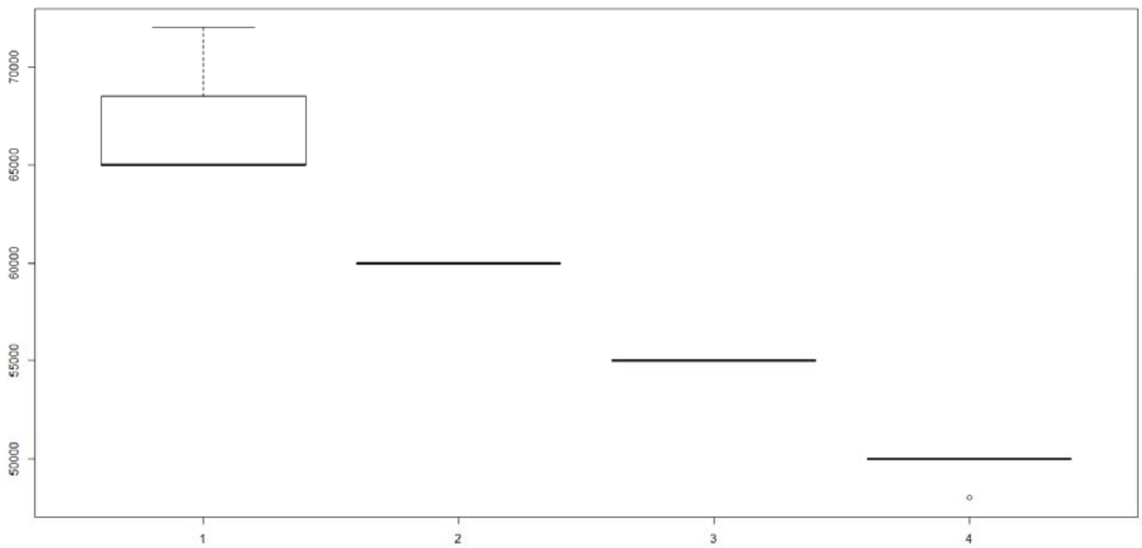

Figure 9. Box plot showing the value of each class for the variable of planting density.

Table 21. Modalities for the different variables, and the percentage each class represents from the total sample

Modalities	# of Modality	Ranges	# of farmers	% of total sample
TotLandQ	1	90-130	3	10.7
	2	70-50	5	17.9
	3	30-20	7	25.0
	4	**1-20**	**13**	**46.4**
CultiRatioQ	1	1	7	25.0
	2	0.50-0.85	7	25.0
	3	**0.25-0.50**	**9**	**32.1**
	4	>0.2	5	17.9
TotFixLabor	1	<24	2	7.1
	2	9-12	4	14.3
	3	5-6	5	17.9
	4	**4-3**	**14**	**50.0**
	5	2-1	5	17.9
FamRatioQ	**1**	**1**	**17**	**60.7**
	2	0.6-0.8	2	7.1
	3	0.2-0.3	4	14.3
	4	0.0-0.2	5	17.9
TempLabor	**1**	**Yes**	**25**	**89.3**
TempLabor	2	No	3	10.7
DensityQ	1	<65000	3	10.7
	2	**60000**	**16**	**57.1**
	3	55000	3	10.7
	4	>50000	6	21.4
PriceQ	1	0.44- 0.50	3	10.7
	2	**0.27-0.36**	**17**	**60.7**
	3	0.20-0.25	8	28.6
				0.0
CattleQ	1	40-70	6	21.4
	2	10-30	4	14.3
	3	**0-3**	**16**	**57.1**
No-rotat	**1**	**No**	**15**	**53.6**
Rotat	2	Yes	13	46.4

During data analysis, the decision was made to drop the two largest farms (400 and 300 hectares) from the sample for the MCA due to their 'exceptional status' in comparison to the other pineapple producers. By doing this it allowed the detection of more subtle differences among the smaller producers. Which would otherwise be masked by these "outliers". The classification made by the presented MCA and HC will be result in a typology for only small and medium farms (<150 ha). However, the two "very large farms" are still presented and discussed in the results because of their economic relevance and future potential.

The MCA includes a relatively small number of factors (axes) that represent the relationships among many inter-correlated key variables of the RHN producers. This analysis permits to select the five first Axes, which explain 60.4% of the total variability from pineapple farmers in the RHN sampled (Table 22). Normally the minimum normally utilized in this kind of analysis. "Accounting for the total variation among the studied entries to a high degree with the first two or three PC"(Madry, 2013). The correlations among the classes of variables for Axis 1 through 3, which accounted for 41% are shown in Figure 10; however, for purpose of clarity only the classes with the highest contribution to the MCA are being shown.

Table22. Projected Inertia obtained from the MCA.

Projected inertia (%)					
	Axis 1	Axis 2	Axis 3	Axis 4	Axis 5
Cumulative Variability	17.0	30.5	41.1	51.1	60.4
% Variability explained per Axe	17.0	13.5	10.6	10.0	9.3

A cumulative variability of 60 % was the threshold for this analysis, since is the minimum normally utilized in this kind of analysis. "Accounting for the total variation among the studied entries to a high degree with the first two or three PC"(Madry, 2013)

The positive values for Axis1 in Fig. 10 represent the largest farms with the highest land (totland. Q1), the highest total fix labor (totfixlaborQ1), the absence of temporal workers (templabor.no), the highest planting density (densityQ1) and lowest for family members working (famratioQ4). In the purple shaded text section an interpretation is provided of the link between different axis and specific farm properties.

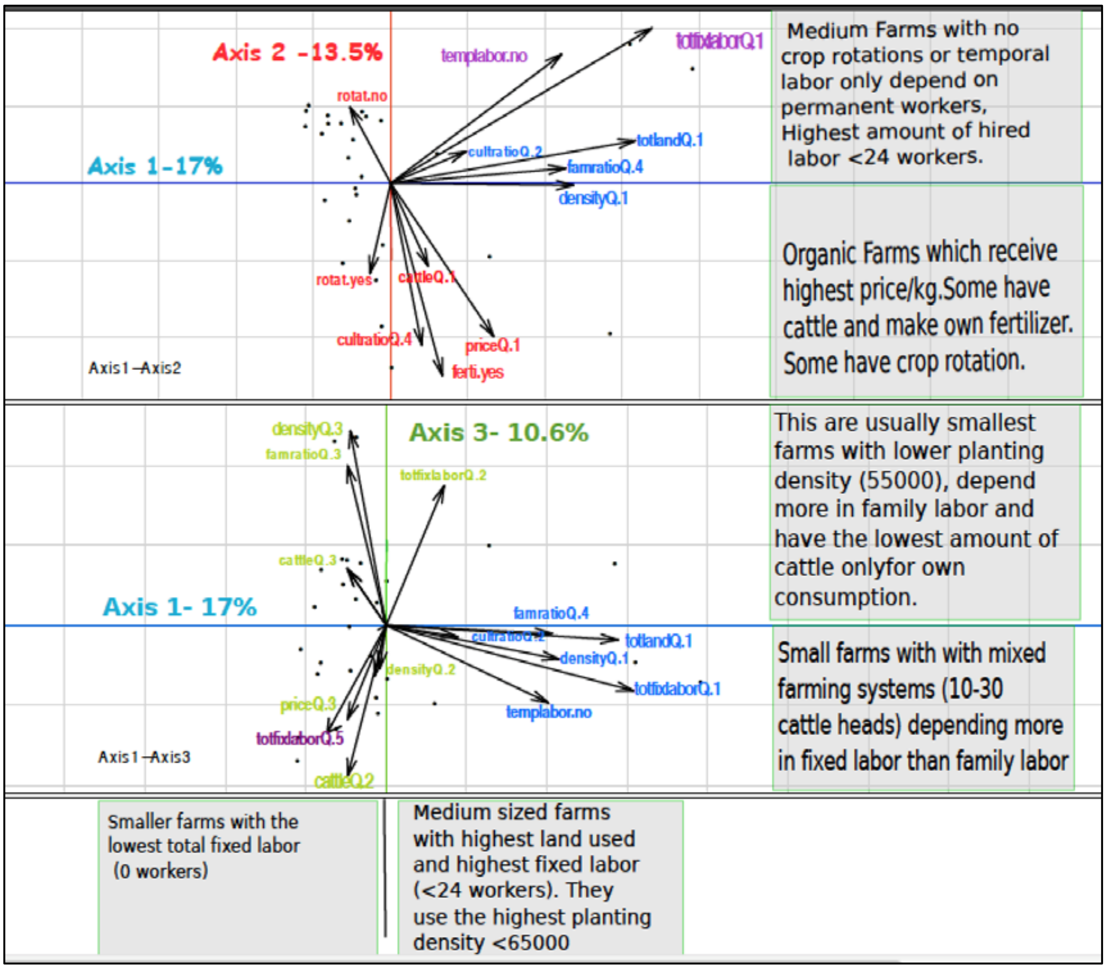

Figure 10. . Factorial planes 1-2 and 1-3 from MCA with only the modalities/classes having the highest contributions being presented. The blue modalities refer to the horizontal axis (Axis 1) , the red and the green modalities to Axis 2 and 3, respectively while the purple shaded modalities are interpretations of both horizontal and vertical axes in terms of general farm characteristics.

The positive values for axis 2 are related to no rotations on the farms (rotat.no) and purple shade color like highest total land (totlandQ.1) and highest fixed labor (totfixlaborQ.1).

The positive values for axis 3 are mainly related to the second highest total fix labor (totfixlaborQ.2), this are normally related to the organic farms. Since 2 from 3 are have fixed workers.

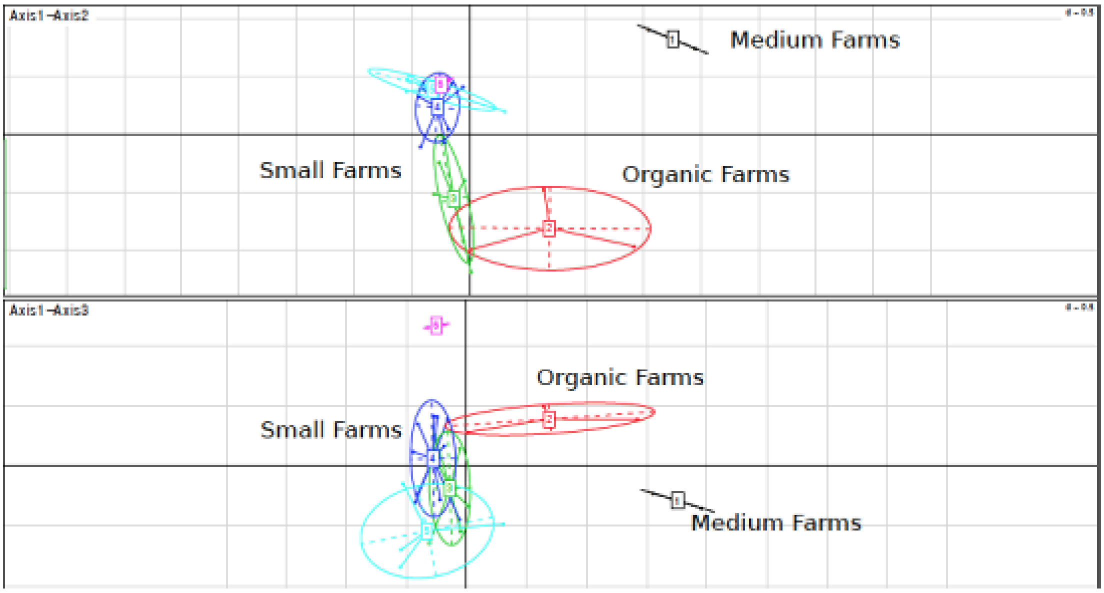

Figure 11. Representation of six types of pineapple farms from the MCA factorial planes defined by the first three factors (Axis 1, Axis 2 and Axis 3).

A factorial maps grouping for the different farm types across the different X-axis is presented in Fig. 11. This figures shows the farm types related to the variables presented in factorial map in figure 10. The characteristics presented in Fig. 10 relate directly to the grouping above. Medium farmers for example have no temporal labor and have the highest number of fixed workers.

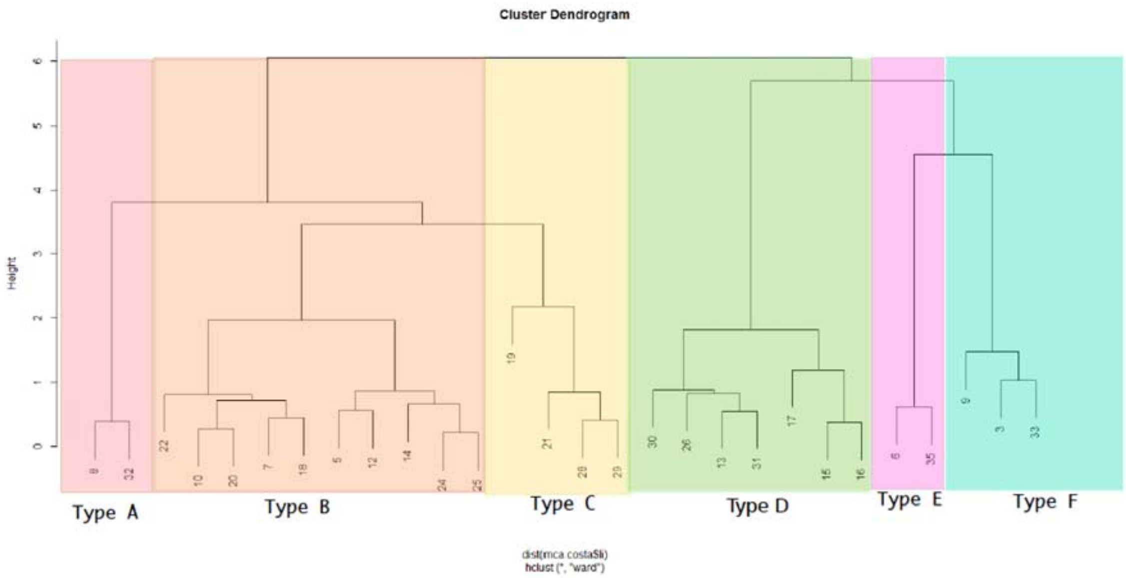

Figure 12. Cluster Dendrogram obtained from the Hierarchical Clustering showing a classification of 28 pineapple farms selected for the analysis. Each number represents a farm from the RHN. Each color represents a different cluster or farm type. A 7th farm type was distinguished but is not shown in this Dendrogram and it relates to the two very large farms (>250ha).

The different farm types are also being depicted Fig. 12 using a cluster Dendrogram that also shows the number of farms per cluster. Different colors represent different clusters with cluster a referring to Medium farms, B to Organic Farms, while C, D, E, F include different types of small farms. These small farms were differing in terms of specific modalities. A more detailed description of each farm type if provided in the next section.

3.4 Detailed characterization of farm types in RHN region

Based on the MCA analysis six main farm types of pineapple were observed in the northern region of Costa Rica. In this context, the largest producers were not included in the analysis but they were distinctly different from the other types. In the next section each of these farm types if being described in more detail in terms of key farm chacteristics.

Small-holder Producers- Types A, B, C, D

Smallholder producers are characterized by not having fixed labor but instead they primarily rely on family labor, especially sons while daughters normally carry out administrative work and may also help with general logistics. These farms only employ temporary workers for tasks labor demand tasks during labor peaks including planting or harvesting. Most small producers have loans with the banks some of them can make the payments on time while some carry unresolved debts. In the next section specific differentiating characteristics among small producers will be discussed in more detail.

Type B & C Very small farms

Type B (n=10) represents the group of farmers with smaller areas referred as *micro producers*. In this case there is no diversification of production activities and the entire farm is used for monoculture of pineapple.

Type C (n=4) corresponds to mixed farming systems which have livestock for home consumption, this means they are less intense farms which practice rotations including pastures and pineapple. They are characterized by owning 1- 20 ha of land. They rely on credit loans from national banks (mostly Banco Nacional). These are the most fragile producers, which do not have enough money to reinvest in their farm. Besides these producers are also burdened with previous unpaid debts. These farmers show slight signs of modernization; they do not posses much machinery, which means they must rent this machinery.

Type A & D- Small Farms

This group of small holders shares some of the characteristics mentioned above including dependence on family labor and credits loans. They also use hired temporary workers for harvesting and planting tasks. Differences resulted in a distinction between types B and D referred to as small *producers*. Both types own or rent around 20-70 ha.

Type D (n=7) is being characterized by having diverse activities in their farm, besides pineapple growing. Some of the most common activities in the area appeared to be dairy farming (Costa Rican Cooperative called Dos Pinos). "Dairy farming pays the bills while planting pineapple allows us to have extra money for other investments", said one of the producers. Other common activities were to plant other crops like root and tuber crops such as cassava and yams. This allows these producers to have enough profit from their harvest to grow or invest in mechanization (machinery) and processing practices.

Type A (n=2) differs from D in terms of it having no diversification and farmers allocating all their land to pineapple production. This group of producers had a more stable income than the very small producers of the RHN, which may be related to economies of scale.

Type E- Medium Producers

Type E (n=2) is characterized by farm sizes ranging from 70-250 ha. They were all individual farmers with having access to either national or foreign capital. They employ a farm manager (either an engineer or the owner) and over 24 fixed workers. They comply with certifications under the labels required by commercial and packing companies, like Global Gap and Tesco. They are still dependent on buyers and commercial companies to sell their pineapple. But normally they can negotiate contracts and better prices than smaller producers because they have larger volumes to supply regularly.

Type F- Organic Producers

Type F (n=3) is the most diverse group of farms. In this group included different size operations that use organic production methods. The main characteristic of this type is the fact that they receive the highest price of all the pineapple producers for fresh pineapple: 0.30-0.47$/kg. They have rotations with leguminous plants or fallow as obliged by organic EU regulation. But when you compare the organic medium- small or big producers with the conventional producers they share the same characteristics as the ones presented above for the other groups, except for the price.

Type G- Large Producers

Type G (not included in Fig. 12) is the group of the largest producers (n=2) that are characterized by having over 250 ha planted with pineapple. Often companies manage the farms and farms are characterized by having large number of fixed labor (>300), own machinery and a packing station. They are considered enterprises owned either by individuals or companies. They export directly to importers in USA and Europe, with no intermediaries. They use the highest planting densities compared to small and medium producers (72000 plants/ha). Large producers are not affected as much by international prices as the small and medium producers. Moreover, they can play with prices since they have much more volume than any of the other producers or cooperatives. There was little interest in participating in this study by this group. Therefore the number of big farms included was very low, even though they are among the easiest to characterize and identify.

Table 22. Summary of Characteristics of the 7 farm types resulting from the Multiple Correspondence Analysis and the Hierarchical Clustering performed on 28 farms from the RHN.

Type	**FARM CHARACTERISTICS**	**# Farmers**
A- Small Farmers with no diversification	The biggest small conventional farmers with land sizes that vary from 20-70 ha. They get a price for pineapple above 0.25 $/kg. They have no cattle and are they are the only farmers that cultivate all their total land. They depend mostly on temporary labor.	2
B- Very Small Farmers with no diversification	This is the group of Small Conventional Farms from 1-20 ha; they have no cattle in their farm. They depend mostly on family labor but hire always temporary labor during labor peaks like harvesting and planting. They do not cultivate all their land with crops.	10
C- Very Small farmers with mixed farming systems.	This group of farmers has farm sizes that vary from 1-20 ha. This farmers receive the lowest price for pineapple: 0.20-0.25$/ kg. They have 10-30 heads of cattle in their farms. They depend mostly on family labor but hire always temporary labor during harvesting and planting	4
D- Small Farmers with diversification	Small conventional farms larger then 50 ha. All farmers have mixed farms with cattle (mostly above 40 cattle heads); these are the farms that rotate the most between pasture and pineapple. They all hire temporary workers.	7
E- Medium Size Farmers	Farm with the largest land sized farms from the sample (from 100 – 90 ha), no temporal labor, the highest total fixed labor <24 workers and the second highest price (0.30$/kg). They are both conventional and individual producers.	2
F- Organic Farmers	Organic Certified farms that receive the highest price paid per kg (> 0.30 $), they use basic crop rotation including leguminous plants to comply with EU certification regulations) . Most of the producers are individual; there is only one farmer that was part of a cooperative.	3
G- Large Farms	Farms that cultivate more than 250 ha (in this case 395 ha organic farm and 282 conventional farm). They depend on hired labor (normally more than 300 workers). They own their packing station and export the pineapple directly to their buyers. They have no cattle and do not cultivate the total land available in the farm. They usually receive the highest price besides the organic farms. Above 0.35$/kg.	2

Note: Only characteristics, which made a difference, were presented on the table. Keep in mind that this is a mean of different variables as a common denominator in the groups of farmers. Group G does not correspond to the MCA it is a deduced type.

3.3 Sustainability Assessment of different farm operations

3.3.1 MESMIS Analysis

There were three farms that provided more detailed information regarding their 2013/14 pineapple production cycle. The first operations were large (> 250 ha) and are referred to as "Organic" and "Conventional" and both were owned by the same company. The third farm being a smaller farm using agroecological based techniques. This last farm may be considered to be some type of model farm since it uses design techniques and management practices that appear to be more aligned with ecological principles and sound agronomic practices. In the following analysis only the first pineapple harvest was considered without taking into account the costs for the second harvest. The farms also provided information on soil analysis for different plots, erosion/ha, production costs, yield/ha, social programs and input use which are outlined and specified in Table 24.

Table 23. Sustainability Indicator Scores for three pineapple systems: Large Conventional (C) and Organic (O) Farm (both and an AF (Agro ecological Farm) in original units and as percentages (in parenthesis) of reference values (Table adapted from S. Lopez-Ridaura et al.2002).

Attribute	**Farms Indicator**	**Unit**	**Organic System**	**Agroecological System**	**Conventional System**	**Optimum (100%)**
Economic	Yield	Ton/ha	72 (80)	60 (66.7)	66 (73.3)	90
	Selling Price	$/kg	0.43 (64.2)	0.67(100)	0.36 (53.7)	0.67
	Production Costs	$/ha	25,329 (100)	N.A	16204 (80.2)	0
Environmental	Soil Loss	Ton/ha/yr	1 (0)	1 (0)	70 (0)	0
Soil Quality	Organic Matter applied	Ton/ha/cycle	40 (100)	N.A	0 (0)	40
	pH	Numerical	4.4 (88)	N.A	4.1 (82)	5
Stability	Crop Rotation	Numerical Score	2 (40)	4 (70)	1(20)	5
	External Dependence	Numerical Score	3.5 (50)	4.5 (90)	2 (40)	5 5
Social	Profit Share-by Workers	Numerical Score	5(100)	3.5 (70)	5(100)	5

Even though the organic farm had historically lower yields compared to the conventional farm (20% according to farm manager), in 2014 during the first harvest, the yields for the organic farm were 6 ton/ha higher. The farm has been developing its practices based on actual farm experience, while continuing to be searching for more efficient fertilization techniques, land preparation and other promising practices.

Differences in farm performance for the larger farms (conventional vs. organic) are presented in Table 25. From this table it may be concluded that total production cost for organic are about 50% higher compared to conventional systems. It appears that major part of the extra production costs are related to sustaining soil fertility through the purchase of imported soil amendments. A more detailed analysis of input allocation is provided in Table 26. The main observation there is that organic pineapple appears to be receiving much higher N-input rates, which in a way could cause environmental problems (e.g. N leaching)

Table 24. Comparison Production Costs /ha of CF and OF 2012.

Activity	Organic	Conventional
Machinery and Equipment		
Weeding	Mechanical	Herbicide
Management of crop residues	Decomposers microorganisms applied	Herbicide & Machinery
Hormone application to have homogeneous plantations	Only at flowering time	Only at maturation
Costs	**$ 8567.19**	**$ 6597.22**
Materials		
Fertilizing	Organic Amendments	Urea and other chemical fertilizers not allowed in OA.
Seeds	Buys conventional suckers because of initial health status.	Uses their own seed, no extra charge.
Costs	**$ 10921.74**	**$3,827.46**
Labor		
Weeding	Plastic Cover and removal	Herbicide
Costs	**$4,259.68**	**$4,192.69**
Total Costs/ ha	**$25,329.65**	**$16,204.68**

Even though prices may be higher for the organic produced pineapple the substantial increase in production costs may not offset this especially since yields may be up to 20% lower than in conventional. According to managers and farmers yields for conventional pineapple were around 52 ton/ha previous years and this yield gap needs to be closed in order to improve the profitability indicator (economical).

Table 25. Comparison between fertilizer and machinery input use and corresponding yield of the organic vs. conventional pineapple.

Input	Organic	Conventional	Difference
Fertilizer	659.75 Kg N/ha	347.76 Kg N/ha	311.99 Kg N/ha
Machinery	165 hours machinery	151 hours machinery	14 hours machinery
Labor	4,259.68 $/ha	4,192.69 $/ha	66.99 $/ha
Output	**72ton/ha**	**66ton/ha**	**6ton/ha**

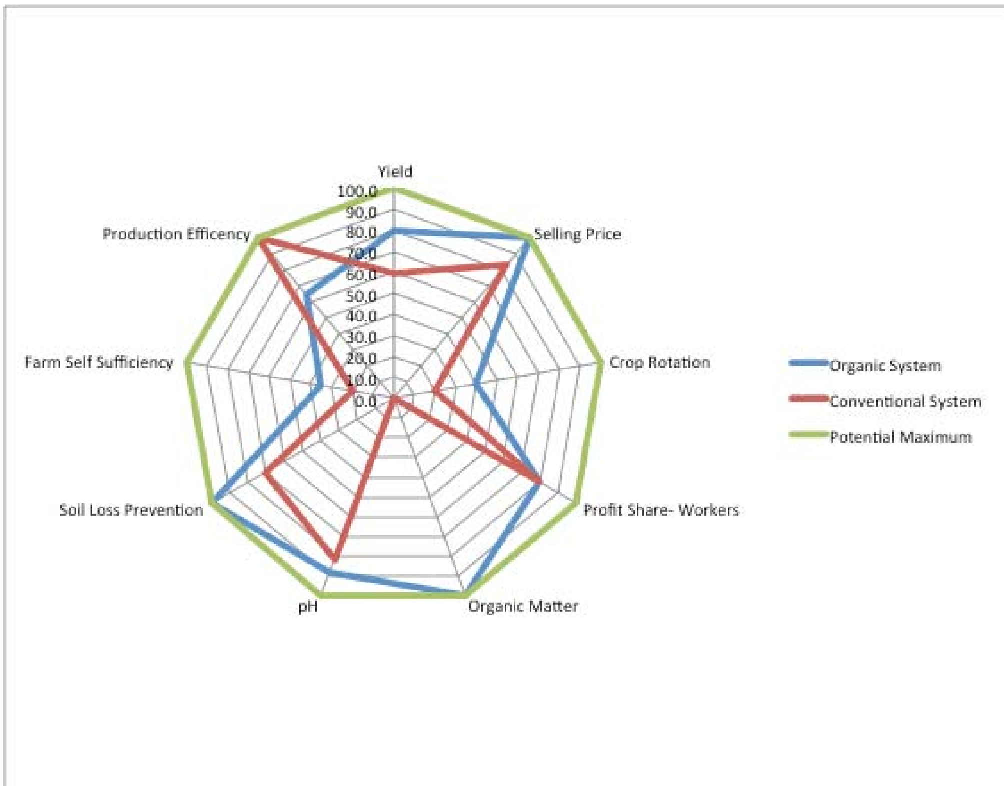

Figure 13. Sustainability Indicators for two pineapple systems from RHN using an AMOEBA diagram (adapted from S.Lopez-Ridaura et al.2002). Indicators and optimum values were derived from the farmers, literature and evaluation team.

A graphical depiction of the difference between organic and conventional systems in terms of selected sustainability indicators is shown in Figure 14. Scaled values were derived from the information provided in Table 24. For example the production costs of the farms were used to calculate the % of production costs. By taking the lowest production cost (CF) and dividing it for the farms (Organic vs Conventional) production costs. In most of the cases the farm that scored higher for an indicator, for example OM aggregated (OF aggregates 40 ton/ha) this was considered the optimum for all farms.

Based on Figure 14 t appears that the organic system has a higher sustainability performance for most indicators. The indicator in which the OF is scoring poorly is production costs (costs/ha). Even though they are exceeding the productivity per ha of the CF the costs are still relatively high thereby reducing profits eventhough that conventional products generate less per kg (see Table 19). There are several aspects in which large farms like the one evaluated here can still improve (crop rotation, external dependence, productivity, among other variables). In general the aim is to have the lowest production cost. As shown in Table 16, the production costs per ha for large organic farms is much higher than for conventional farms. In 2013/14 the difference was $ 9122. Based on Table 26 this is mainly attributed to fertilization materials, plant health (buying of suckers) and the application of inputs in order to support decomposition of the plant residue. Even though the conventional system typically requires more inputs (especially agrochemicals) compared to the OF, the cost associated with approved organic inputs (such as blood meal for fertilization) is much higher. However, use of waste products of the bio-industry, as a soil amendment is somewhat questionable, especially at the excessively high application rates that are being used. Development of more sounds organic fertilization schemes based on sound crop rotations and plant-based organic amendments including composts thus may be a relevant research inquiry for organic producers.

In terms of soil degradation indicators (ecological) the OF performs much better because they use plastic mulch covers through all their fields. This is a standard practice implemented by most organic farmers. Even though it increases production costs slightly, it is the only effective technique to manage weeds so far. Ecological indicators were complicated to gather, not much information is yet collected concerning this topic. Erosion is a clear indicator in soil quality, a clear difference of 69 tons/ha/yr has been found for these farms. Of course this data will depend on the area, topography, soil and climate of each farm (Gauggel, DOLE expert, personnel communication). Besides the blood meal, the farm also applies 40 ton/ha/cycle of compost, which provides a substantial amount of organic matter to crop residue. Even though the organic system performed in many cases, the lines are at times rather close together, which means there is still room for improvement. For indicators like external dependence and crop rotation (stability), the OF has a higher score when compared to the CF. However, something to emphasize is the fact that the OF shows a high dependence on external inputs. As shown in Table 26 the OF utilizes double the amount of N/ha (311.99 kg N/ha) than the conventional farm. This means the OF is highly dependent of external inputs such as the presented organic amendment. The difference in yield between the farms is only 6 ton/ha, which does not justify the excessive use of organic amendments which in turn may cause environmental impacts and reduce profitability. In terms of categories such as machinery and labor differences were less pronounced.

Since there was less information for the Agroecological Farm (AF) only selected variables could be assessed and the relative scores for these variables are inserted between brackets in Table 24. In this context it is relevant that the agroecological system did receive the highest price/kg while this farmer only sells his product in the local markets in Costa Rica. In local markets producers get higher payments for their produce since they are the ones earning all the profit without sharing with other intermediaries. Recently these producers also started exporting dried pineapple pieces to the US.

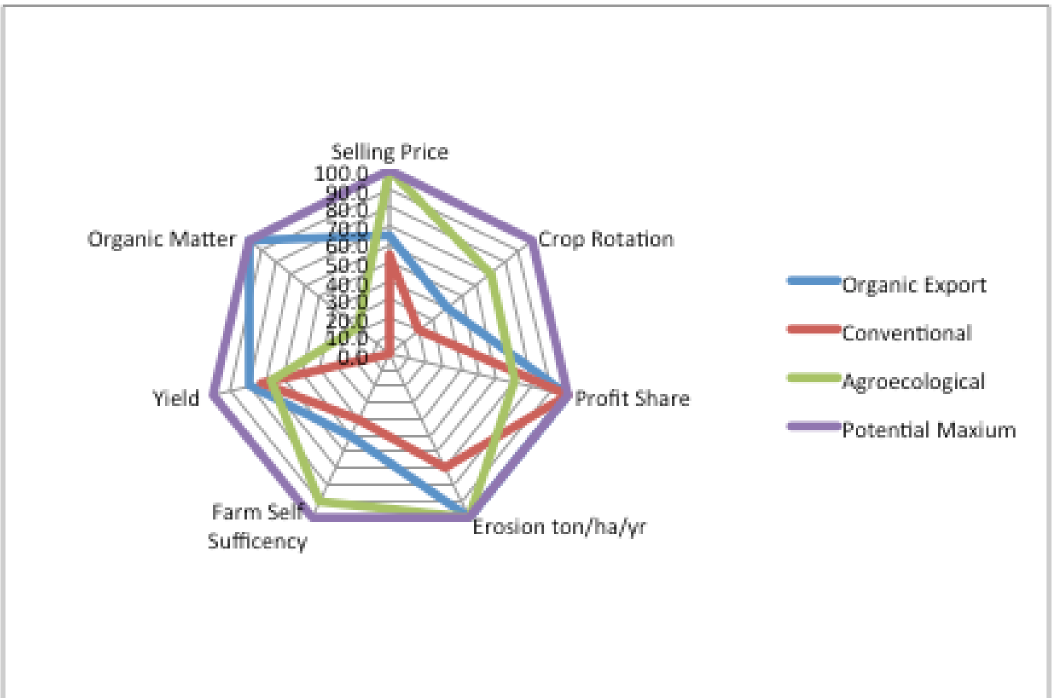

Figure 14. Performance of conventional, organic and agroecological managed pineapple systems for selected sustainability indicators in RHN (adapted from S.Lopez-Ridaura et al.2002). Indicators and optimum values were derived from the farmers, literature and evaluation team.

The indicators, for which the AF performs lower, are pineapple yield, organic matter addition, and profit share. These kinds of farms, which sell locally, have a lower quality demand from local consumers. This is one of the reasons why the producer does not use excessively high rates of organic amendments in order to attain maximum yields. Even though the producer uses very different practices compared to the larger farms, the yield gap is relatively small and yields may be increased using simple changes in the agricultural management practices. In terms of the profit share, the smaller producers in the country have very low cash flow due to smaller volumes they produce. Certifications schemes such as fair trade are quite expensive to consider while consumers in Costa Rica may not find added value for this kind of certification standards and/or labels. Therefore, another type measure for profit share may be needed to better evaluate the performance of smaller farms. Another issue is that small producers normally rely mainly on family labor, which is undervalued in the analysis.

3.4 SWOT analysis

The previous information is being complemented using a SWOT analysis format to compare small- medium organic producers vs. big organic producers based on interviews and farm observations (Fig. 13). It appears that big farmers have tools and personal to help strengthen investigation in organic production knowledge gaps. Smaller producers are more willing to experiment in new crops, markets, farming techniques. Small producers lack organization for export and commercialization in contrary to the big farms. Companies like EOSTA like to market products with nice stories to tell (nature and more website: www.natureandmore.com).

STRENGTHS	WEAKNESSES
Small Producers -Have a good relationship with other producers in cooperatives; knowledge can be easily exchanged among farmers. -Can benefit from governmental incentives and technical support. -Many own the land and want to preserve it for future generations. Lot of room for improvement and more willing to try out new production techniques. Large Producers -Have technical support and staff capable of carrying out on-farm research. -Own their packing stations for exporting products and can engage very easily with clients. -They have enough volume to supply the large demand of overseas organic niche markets. -Uses internal resources (residues, manure, microorganisms, etc.) as much as possible.	Small Producers - Lack negotiation power and market knowledge and management skills. -Difficulty to maintain production standards that comply with international quality standards (not the case for medium producers). -Depend on commercial companies and intermediaries to market their pineapple. - Lack of organizational skills for farmers group. - Depend on external financing for operations and/or innovations. - Depend always on assistance of technical support. - Large Producers - Depend mainly on monocultures. - Do not want to share knowledge with competition or share market niche as organic. -Lack of knowledge of organic production techniques. Pineapple fields are managed as conventional fields with approved organic inputs. -Large land extensions lead to high crop residues, which makes management trickier. -Utilizes high amounts of resources. Natural amendments and synthetically approved ingredients. - Have a limited amount of on-farm renewable resources. They have no available nitrogen on the farms. No animal manure only crop residue available.
OPPORTUNITIES	**THREATS**

Small Producers - "Small is beautiful" concept sells well in supermarkets, niche production. - Financing for supporting family farms is available. Big Producers - Markets are driven to more ecological and sustainable production. International markets need volume.	Small Producers - Small producers have no technical assistance but companies or input sales managers, which sell technological packages. -Loosing landowner ship to big transnational companies. -Regulations and communities oppose pineapple expansion - Further increases in the production costs due to rises in inputs, machinery, etc. - Declining market prices and over-production Big Producers -Soil quality deterioration. -Regulations and communities are against the pineapple expansion. - The big monoculture lands, fertilization schemes, and other practices do not fit consumer image of organic. -Further increases in the production cost because of the rises in prices (inputs, machinery, etc.).

Figure 15. **SWOT Analysis for Big organic pineapple producers and small holders.**

3.6 Differences in constraints and management strategies among farm types

There were some clear differences in production efficiency (referring to producing at the lowest cost without depending on resources external to the farm) and resource endowment (refers to the available resource) among different producers analyzed from their farm performance. Big organic farms utilize great amounts of resources like organic amendments and synthetically approved ingredients. They have a very limited amount of resources available since they have no green manures or animal manure for nitrogen supply. Instead they import all the nutrients from other exploitations to supply the nutrition needed for the plantations. As a result, they have the highest production cost per hectare across all farms. They do have resources like hired labor (high costs involved) and a technical support from a team of agricultural engineers and specialists, which have access to information. This also applies to large conventional farms.

Organic farms targetting the internal market supply exploit internal resources as much as possible, using crop residues as fertilizers, and mixing this material with animal manure from their farms, they also produce their own seed, use both intercropping and crop rotations. As a result, they have a more diverse production system, which allows a varied income within specific markets. However, these markets are rather limited and do not allow rapid expansion. especially since there is a lack of planning in terms of opening up broader internal and external markets. It was also observed that producers tend to focus predominantly on production and profitability on the short run and lack strategic planning and long-term goals. Usually these farmers have a more limited cash flow and depend on family supporting all tasks in the farm (uncalculated Subsidy).

3.6.1 Perceived problems of different farm groups in RHN

Table 26. Scoring of problems identified by the farmers of the RHN, separated by size and not farmer types obtained during the MCA.

Problem Identified	Small Farms	Medium Farms	Large Farms	Organic Farms
Agronomic Problems				
Erosion Control	++	+++	+++	
Residue Management	+	++	+++	
Diseases and pest	+	++	+++	+++
Fertilization Methods				+++
Technical Support	+++	+		+
Market Problems				
Access to markets	+++	+		+
Price fluctuations	+++	+		+
Negligence from Buyers	+++			
Economic Problems				
High production costs	+++	+++	+++	+++
Input costs	+++	++		+++

+++ Affected severely
+ Less affected

Problems identified by the farmers during interviews

Technical support
Many producers depend on their own knowledge or on the advice from agrochemical companies. Many engineers in Costa Rica sell packages of inputs to farmers which are not aiming to minimize input use (e.g. integrated pest management techniques) but rather focus on preventive usage of agrochemicals. However, environmental restrictions, regulations and certification demanded by buyer make it tougher for farmers to produce without technical assistance.

Market and prices
Intermediaries and commercial companies in the area are controlling the market. Depending on the supply and demand of pineapple, they can adjust prices by paying more or less, making it hard for producers to make profit while production cost remain the same or even increase. In 2006 pineapple was a very profitable business and farmers received approximately $0.46/kg, which made the business lucrative especially because production costs were lower $0.20-0.25/kg depending of the producer. During the last couple of years prices per kg have declined and are currently fluctuating from $0.23- 0.32 /kg for fruit sizes 6, 7 and 8. With such low

prices the profit margin is slim or negative, especially when the cost of external inputs and labor keeps increasing. When demand is high or low quality fruit is rejected at the packing stations, this is affecting those who don't have enough volume to negotiate (small producers) the most. Since these producers tend to face more challenges while maintaining fruit quality and also have limited financial buffers.

Difficulty to collect payments
Many of the buyers and commercial companies fail to pay the producers for their pineapple. Many producers are owed thousands of dollars because the negligence of companies to pay the money in the absence of legal contracts. It is unclear why intermediaries are not paying the money to the producers, some intermediaries claimed that the buyers were not paying the product when it arrived at its final destination or the container was send back because quality issues. (Source: producers and intermediaries)

Financing
Most of the growers interviewed stated that their operations were funded mainly from their own means. Due to price fluctuations and cash flow problems arising, they had no option but to request private loans. Having credits unpaid by Proagroin obliged the producers to end the relationship and take credits with banks to pay their initial debts. This does not allow them to have the financial possibility to continue in the business of planting pineapple.

Buyers Credibility
Especially smaller and medium-sized producers are loosing faith in the buyers. Either way due to lack of direct access to external markets they have no choice but to sell their pineapple to whom ever buys it locally.

Lower costs for fertilization
Organic producers, most of the problems (Annex 2) revolve around fertilization issues and disease management, mainly because of restraints from organic regulations.

Erosion investigation
In Costa Rica on going investigation target to reduce water erosion in cultivars of pineapple in the region. Producers and stakeholders are concerned by the enormous quantity of soil erosion that goes on in their farms. Much investigation is done in large farms like PINDECO and DOLE. Reduction of erosion has been effective, but not enough to prevent that thousands of ton of soils are lost each year. The actual systems are variable but they are focused on being cheap, with little technicality, aimed at improving drainage using basic mitigations. In general they do no tend to fully control erosion but just comply with environmental requirements and infrastructure maintenance (Presentation Chiquita, date?).

Fly management (Stomoxyscalcitrans) and crop residue management

Pineapple farmers have been blamed for the proliferation of the "mosca del establo" (stable fly) throughout the region. The large amount of residues left in the field after harvest has attracted this fly to reproduce in the residue. This is affecting cattle farmers directly in the region; because of the attacks of the fly the cattle stops eating, loose weight and have lower productivity (EARTH, incomplete reference).

Management of stubble to manage fusarium

The farmers expressed concerns about *fusarium oxysporum* a soil-borne disease, which is increasing during the past years. For organic farmers it is even more complicated because they depend on biological inputs, which are not effective as agro chemicals. But even for conventional farmers although the use of fungicides to control this disease is increasing, it is still present in the fields. Generating information and technologies for better managing this fungus by studying its life cycle thus is needed.

3.6.2 Farm practices, markets, and innovations

When comparing different farm sizes an, market orientations and innovation within the pineapple value chain we can see a clear difference between farm operations. During the interviews two farmers that had rather interesting farm operations, these farms were thus chosen for further analysis to see if there were differences in practices as related to their marketing strategies. Organic farmers have a specific niche in which they sell their pineapple either to local or external markets. When it comes to market orientations pronounced differences were observed between productions for local vs. international markets.

Local markets

When producing for local markets, farmers are clearly more interested in having a variety of crops to sell in the organic fairs.

1.) Carlos Viquez (Cash Crops): Cassava, papaya, arugula, lemon grass, turmeric, ginger, and basil, among many more. Carlos has almost 100 crops planted in a 3 ha garden. He has not been able to expand because the internal market is limited in terms of the demand for certified organic products. His farm is around 120 ha with cattle for meat production. This farmer has plenty of area to expand provided he would have access to other markets. (Figure 16 and 17).

For local markets the farmers are clearly more interested in having a variety of crops to sell in the organic fairs.

2.) Carlos Viquez (Cash Crops): Cassava, papaya, arugula, lemon grass, turmeric, ginger, and basil, among many more. Carlos has almost 100 varieties planted in a 3 ha garden. He has not been able to grow to higher densities because he has no internal market with such high demand of certified organic products. His farm is around 120 ha with cattle heads for meat; he has plenty of area to expand if he gets an interesting proposal toward other markets. (Figure 16 and 17).

Figure 16. Fruit Nursery Field: lemons, star fruits, bananas, and legumes hedgerows.

Figure 17. Intercropping with basil, lemon grass, turmeric and papaya plants. Irrigation for cash crops (greens). Mulch with lemon grass.

Alberto Chinchilla: pineapple (main crop), turmeric, melon, banana, passion fruit, and peanuts, among other crops. Alberto has more land allocated to his crops; he has less intercropping but depends more on rotation schemes. He has taken over the market of pineapple in the organic fairs. He also has become an entrepreneur as he recently started to engage in processing and is producing dehydrated pineapple and other crops (Figure 19 and 20). By diversification in crops and added-value (preservation) process he even found a market outlet for the organic peel of pineapple for making teas.

Figure 19. Dehydration Plant for processing different products.

Figure 18. Dehydrated Pineapple and Plantain from Alberto Chinchillas farm.

Figure 20. Lombricompost and other liquid fertilizers, MM, (mountain microorganisms) among other mixtures.

Figure 21. Compost pile from cow manure and crop residues.

Figure 22. Bioferment production in 12 ha organic farm of Luis Fernando from Cooperative Coopepiagua

Both producers had a different approach towards agricultural practices. Both of them use techniques like: composting with residues and animal manure, liquid fertilizers (Fig. 21, 22 and 23), mulch (Fig. 17), seed saving, crop rotation (Figure 16 and 17), intercropping, among many more. In the ecological aspect organic small holders oriented to local markets tend to use more sustainable practices. They are less dependent on external inputs and agrochemical companies since they try to make optimal use of internal (on-farm) resources.

They also obtain a higher price per kilogram of fresh produce due to the direct marketing approach they use as they sell their produce in the local markets (fairs, processing, restaurants). However, they sell smaller quantities of products but producers have enough income to sustain their farms and maintain their livelihoods. Even though, they would be interested in expanding their production scale to increase their income.

Since they have various products available at different times of the year profitability indicators were hard to gather. These producers do not have a steady income, since they have complex crop systems rather than a monoculture. This is an aspect that needs to be addressed when studying and supporting small holders producing for local markets since they do not have an organized system for record keeping.

In the case of the large organic farm although they have a lower ecological score it performed well in terms of social aspects. This because they are in a special program with special fair trade program, in which they have constructed an after school for workers and their families and people from the adjacent communities. This farm is the only pineapple producer, which has this type of certification, which makes it rather different from other farms. Small organic farmers hire on demand, so this regularly means the workers have no benefits. Some farmers have the workers living at their house, as is the case of Carlos Viquez in which his workers live and eat in the farm.

4.Discussion

This thesis report was the initial stage for a project that EOSTA wants to implement to address some of the sustainability issues presented above. Research is being required to guide farmers in Costa Rica during the exploration process for more sustainable production systems. However, in order to develop the project an initial diagnosis needed to be developed with the help of local stakeholders. Consequently a socio-economic analysis of the farmer's problems, resource endowment, production techniques, production capacity, and identification of farmers interested to actively take part in pilot studies needed to be identified first (Dogliotti et al, 2013). For this it was important to map prevailing farming practices and organizational schemes, which later on may be implemented and adopted by different farmers groups (small, medium and large).

Farming systems diversity in the context of this thesis revolves around three factors: resource endowment, production efficiency and external/ internal forces such as market orientation, policies and stakeholders. The main focus of this research was to understand the relationship between the farming types and farm performance (sustainability, constraints and resource use). The uses of typologies support the understanding of different farming systems. It can facilitate identifying key differences in farm characteristics among farmers groups. They contribute to developing suitable strategies for agricultural planning at different levels like policymaking, individual farm strategies, or organizational schemes for producers (Lopez, 2008).

One of the major breaches of the study was the choice of the farms used for the in depth analyzes of their performance. These were chosen based on findings from previous typologies (small, medium and big identified by MAG 2007). Later it was found that the actual farm types were more diverse than expected and the farms chosen for more detailed follow-up studies did not represent all the different farm type. Besides this the time frame and obstacles encountered (missing data, lack of detailed technical information by the smaller farmers included in the surveys, etc.) along the way which made it hard to collect all the information in a timely fashion.

Existing characterizations of pineapple growers were reviewed as part of the literature review. The typology generated by Faure and Samper (2004) separates farmer types of RHN region according to the strategies implemented (Diverse farm system, cattle farms, export, non-export, etc.). By farm diversity he refers to farmers, which diversify by growing multiple crops. This study did not focus on pineapple growers specifically, even though it included them, but it mainly focused at regional scale on all producers. The present study aims to find characteristics of pineapple growers at regional scale in order to identify adopters of alternative farming systems in the region. The term 'alternative' refers to being different from present-day prevailing conventional practices (Daskalopoulou, 2002).

In agreement with a prior study by EARTH University (consultancy by Kellon et al. 2011) in Costa Rica the current study confirmed the existence of 5 farms types: micro, small, medium, large and transnational scales. The current research project generated more detailed information regarding the specific characteristics of pineapple farmers in the RHN. The most vital information came from the fact that there are still mixed farming systems among pineapple growers. None of the past typologies or characterizations of producers in the literature (Kellon, et al. 2011 or Mag, 2007) made reference to this. Even though the presence of more complex farms with multiple farm activities is identified, it is still unknown how farmers are allocating and managing making use of the different resources available like: manure, residues, rotations, etc. So despite the current study there still remains a clear knowledge gap that should be explored further in order to truly understand the differences between this different types of producers. This is essential information for assessing nutrient balances and differences in input use and resource use efficiencies across the diversity of farms. Some of the farmers with nitrogen (manure) available in their farm were using it for fertilization in their fields as slurry, which is a common practice in dairy operations. Farmers with mixed farms are implementing crop rotation between pastures- pineapples and sometimes other crops (cassava and other tubers). These practices could make significant changes in SOM and nutrient balances (N, P, K and other nutrients) among other important soil quality measurements. Other studies like Tittonell et al (2013) measured the diversity in soil fertility of different farm types; this could be an important second step to addition to farmer typologies in the RHN.

Different studies around the world present diverse farming systems. Certain characteristics found in the study in Costa Rica, can be compared to other studies in Latin America. For example in the study in Uruguay by Righi et al. 2011, segregated farms into mixed farming systems (animal husbandry and crops) or cropping systems (specialized). Some other characteristics included the level of modernization, whether they use machinery or not and labor availability: hired or family labor. In the case of RHN the farm typology analysis revealed similar results with the existence of 7 farm types in the northern region of Costa Rica. These include small (macro/ micro mixed farming systems and micro/macro monoculture systems), medium, big and organic farms. While in terms of modernization there were pronounced differences between farmers focusing in internal or external markets and also depending on their farm size.

Farm typologies have been an important tool to explain the diversification among farmers. Sustainability is a relative new concept, which many scholars have been trying to incorporate and link to farm typologies (Pacini et al 2014, Blazy et al 2009,). It was attempted to be able to do a sustainability assessment between farm types but as explained above there was not enough detailed information especially for the smaller farms which requires more frequent monitoring and prolonged record keeping during follow studies.

At the beginning of the study, market orientation (internal or external) was not an important factor for the research. Although once the analysis of the results began, this specific characteristic started to emerge as being a major governing factor that is to a large extend shaping agricultural practices. During the fieldwork different organic farmers were visited, and some of these are producing for export markets while other target mainly local markets. Clear differences were observed and it appears that producers focusing on internal markets are experimenting much more with organic fertilizer production, intercropping systems and alternative production strategies (for example using crowns as planting material instead of suckers). They were having both more diverse farming systems and developing very successful business models for internal markets.

Among small producers, that export, management strategies were less articulated and hard to identify, as was the case for organic farmers dedicated to local markets. The agricultural practices tended to be very similar to larger farms including buying manure and organic amendments to make fertilizers, disease control, land preparation, etc. As shown by the MESMIS analysis, large organic farm's current practices are very similar to conventional, meaning that they have adapted a technological package to organic approved practices (the so called "input substitution" approach). A term used by Best (2008) refers to this process as the "conventionalization hypothesis" which implies that especially large-scale organic agriculture is becoming industrialized and somewhat modified as a model of conventional agriculture. This is a common situation for large commercial farms, which have entered this niche market of organic production. Small organic producers may be incapable of competing with large farms, and in order to subsist economically they have to adapt their farming systems (Best, 2008). This is the case for most of the farmers in Costa Rica, these small organic farmers that export products had to adapt and industrialize their small farms to compete in terms of meeting quality and uniformity standards as dictated by international markets. For many of the organic small farms (1-12 ha) the price premium vs. the cost of certification and corresponding required organic practices: plastic mulch, high nitrogen fertilization, pest control, was too high and organics thus not provide them with a viable (profitable) alternative. Best (2008) describes a phenomenon of " assimilation", in which they adopt conventional practices, and "bifurcation" in which some small producer (low-profit) try to strengthen the connection to local markets and via direct marketing strategies sustain their livelihoods.

But this is not the case for all of them; some innovate doing different things that could not be fully documented during the course of this research project. Even though some smaller farmers were assimilating new techniques and developed their own recipes of bio ferments and bokashi, they still suffered from high certification prices and low payments per kilogram. Size, price and quantity are affecting these producers in different ways. This should be analyzed further to document all the differences and compare farm performances and look at trade off analysis with models or programs like Farm Design (Groot, 2013)

Medium organic producers still pursue similar production schemes as conventional producers, with the difference that some are actually producing their own compost (one produced it with crop residue and the rest bought ingredients to produce it from other farms). So in the case of pineapple is still uncertain which techniques producers might use and which ones may be most viable. Some of the organic producers converted to organic because of the price premium offered to export their produce. Some others showed a conviction towards healthy farming systems because they believe in having less environmental impact. Comparing to other regions of the world it is important to understand the "internal dynamics of the organic sector". In the case of Costa Rica, as was the case of the study in Germany by Best (2008), small family-based farms mainly dominate organic agriculture. However, agribusiness corporations also have entered into organic farming in Costa Rica. And although most of the organic farmers were former conventional farmers, characteristics among farms may differ greatly depending on their size, scope and prevailing strategies.

It was observed that small farmers are still willing to try alternative production models that may include more crop rotation, marketing and crop diversity, more direct and transparent relation to external and internal markets, innovative production techniques among others. These producers face a knowledge gap and lack certain skills and powers as related to recording keeping (including input use, soil fertility monitoring, yield) and securing better prices (e.g. bargaining power and access to networks and information). Moreover, they may lack an understanding how specific production practices and strategic choices affect the profitability and/or sustainability of their system. Moreover, they may not effectively communicate their endeavors to perspective consumers how they aim to reduce negative socio-ecological impacts and to develop more sustainable production systems. This in turn may hamper them to fully capitalize and be rewarded for such efforts. Small to medium sized organic farmers tended to be more economically stable. A common characteristic identified between them was that they were mostly licensed engineers with other jobs (income diversity). Most of them had formal education in either economic or agricultural studies. The other small farmers without any studies or different income activity had also similar problems as in conventional, especially with marketing and financial debts.

In terms of the current study, essential information to understand farm performance, resource allocation and production efficiency is missing. More in depth analysis of farming practices was missing this includes numerical data to further characterize the seven farm types since the surveys used were too general to gather this information.

This study was focused in the development towards techniques for designing farming systems within a co-innovation process working close with important stakeholders of the sector and farmers of the area. This process has been implemented in different case studies in Latin America and the world. The study in Uruguay served this purposes with cattle and vegetable farmers (Dogliotti et al 2013). The process of this project was used as an example and guidance for innovation process for more sustainable farming practices in pineapple farmers. A similar method was implemented in the case study in Costa Rica with the exception that the value chain was a main component of the whole process. The interests of foreign companies exist in the implementation and future of the project, which ultimately makes it a very interesting case study. Involving the value chain in the whole process makes the project very unique.

The results of this thesis thus may be used to develop a proposal for organizing and implementing pilot farms studies. By closely and frequently monitoring farms it will facilitate a better understanding of how farm activities and management as related to marketing strategies affects farm performance over time. These studies thus may provide a scientific base to create alternative business models that can be adopted by different organic farmers and conventional farmers. To identify viable options for more sustainable systems future farm design should be based on the optimization of the entire farm and assessment of different farm components (Dogliotti et al 2013).

5. Conclusions

Currently, consumer behavior has gradually shifted towards preferences for more sustainably produced food commodities. Companies, farmers, and different actors of the production value chain are looking for these niche market opportunities. The needs to meet the demand of natural/agricultural friendly/ fair trade among many other labels provides incentives for producers and traders to invest in sustainable production systems. However, this requires innovation and capacity training and development of local and global knowledge networks as integral part of truly sustainable value chains. Based on a review of existing literature there appears to be a lack of technical assistance, poor management, excessive use of external inputs and mechanization, limited involvement of local actors which have resulted in a general discontent of local farmers.

Even though there is demand for more sustainable management farming systems, there is no clear way on how to measure sustainability in different crops. The only way farmers can comply with this status are the existing organic regulations, which sometimes make consumers wonder: "How sustainable and strict are these labels?" This happens especially with a crop like pineapple since there appears to be little or no difference between systems except the use of plastic mulch as a soil cover, which is not necessarily an appealing image. Pineapple is grown in highly specialized and intensified systems, even though they are organically certified. There are still many challenges towards defining sustainability in a crop like pineapple. It is concluded that it is essential to carry out on-farm research to assess suitable production practices for organic pineapple as related to farm-scale, market orientation and specific production objectives. Currently organic farmers practices are clearly facing challenges adapting the prevailing technological package for pineapple systems. The core principles underlying organic farming (IFOAM) are still not being well implemented by most of these pineapple growers. Pineapple has been identified as being a very difficult crop to produce organically, especially since it is currently produced at such a large scale that prevents sounds crops rotations since farmers were forced to adapt to compete with conventional farmers. The need to study organic fertilization, crop residue management, nitrogen uptake, and bed preparations for disease control has to be further investigated in order to improve the performance of organic farms. The behavior of pineapple with rotations and intercropping systems or even different practices from what we are currently used to are unknown.

In Costa Rica most of the stakeholders in the pineapple sector perceive current production practices as being not sustainable. There are many studies and scholars, which have measured sustainability for different farmers or crops. Through the implementation of this thesis the execution of more sustainable schemes may be explored further. In terms of constraints, small-medium farmers are hampered by mainly debt, production costs, and gaining access to international markets. This can jeopardize the future of family farmers in the region. The information presented in this thesis highlights farmer's perceptions of the main issues and provides a clear justification why they are willing to change the way they are producing pineapple. One of the main conclusions of this thesis is that there is a need for change in current pineapple schemes. Moreover, there is a lot of space of improvement to make these systems more sustainable and adaptable to market needs of the value chain while being profitable for the farmers. Finally, there is interest from the commercial companies including EOSTA to invest in research and as part of a co-innovation approach with farmers and researchers explore more sustainable value systems. Recommendations to structure such research programs are outlined in the section below.

6. Recommendations

6.1 Future Solutions- Project conceptualization

This master thesis project was structured in order to support and identify active involvement of both farmer and other players in the pineapple sector. It targeted key issues and provided guidelines for subsequent design phase and implementation of proper production strategies and management techniques as integral part of developing more sustainable pineapple value chains. Throughout the implementations and planning of this thesis, many possibilities have arisen to structure and implement a project involving farmers in RHN. After analyzing and sharing results presented in this thesis with stakeholders it was proposed to turn this thesis research into a real study aiming to support development of more sustainable pineapple value chain in Costa Rica.

Large organic farms have major assets that can be instrumental for supporting future on-farm investigations related to production. These farms have the proper and professionally trained farm staff, excellent infrastructure, detailed production records along with large and homogeneous plantations where replicated studies could be very easily implemented. However, large farms tend to be reluctant to cooperate with other (smaller) farms, unless it would allow them to gain access to new technologies that may be tested in their farms. On the other hand, small producers are very willing to explore new options and collaborate with other farmers and pursue alternative business models provided the financial investments are modest, the risks are manageable and there are clear short-term tangible benefits. However, these producers distrust most organization, buyers, intermediary, agronomist, governmental agents, etc. This lack of trust and feeling disconnected from the value chain is related to them being victimized by global market forces, traders and other stakeholders higher up in the value chain and the lack of transparency within the pineapple production chain.

At a succeeding phase, funding has been requested to implement and evaluate viable alternative technologies starting with small pilots including different type of farmers (based on farm size and technical knowledge, etc.) If farmers can manage these systems successfully and produce different products in a cost-effective manner this can help them to be competitive in global markets. Organic trading companies such as EOSTA (largest importer of organic fresh products in Europe) has shown interest in investing on sustainable sourcing of organic commodities and other tropical fruits (Personal Communication with Henk Zoutwelle, 2013). Such companies are invested in securing a continuous supply of high quality organic products from Costa Rica and have provided partial financial support for this research. However, support from the local stakeholders is also needed and it appears that the project is well aligned with the current governmental policy to promote ecologically sound production and carbon-neutral agriculture (MAG, 2010 and personal communication October 2013 with Jairo Serna)

6.2 Key focal points for designing pilot studies

Diversification is essential in order to reduce both production and pricing risks by spreading resources and income across different activities/commodities, thereby avoiding dependency on a single commodity and the associated global price volatility. Having different products and producing for different markets appears to be preferable for producers but also requires enhanced organization. Technical support and training of farmers (capacity building) is essential, as is securing suitable and sustainable market outlets for their products in both international and national markets. However, this requires direct involvement and close collaboration among different actors throughout the value and knowledge chains during project conceptualization and implementation to ensure feasible solutions those farmers can readily adopt.

Proposed strategies may include green manures, intercropping systems, crop rotations, compost and market diversification and will include strategies identified during interviews with local producers. This integrated system approach aims to help farmers to gain more autonomy and reduce their dependency on external inputs and intermediaries that control international markets. During a project-conceptualization workshop farmers and other experts were invited to list solutions to help structure more sustainable systems. The work groups focused mainly on problems of organic producers and small holders. Presented below are the main statements mentioned by the groups.

Groups Statements of Solutions

- Household Economy Education: this was stated as a solution to address certain knowledge and information gaps established for small holders. Farmers need to be able to adapt to market changes, negotiate prices and be capable of having enough skills to have a profitable business and to ensure sustainability for them and their family. Fair prices, diverse production schemes, and varied markets both locally and internationally play an important role in this new business model.
- Stable and reliable markets are seen as key elements in assuring long-term sustainability for small producers. This may be facilitated by buyers providing signed letters of compromise and contracts for the producers. This type of compromise can allow the producer to request a loans or insurance for their crops.
- Diversifying production to commercialize more crops to to differentiate and complement income by including: vegetable crops (short cycle cutting greens) for local markets and fruit crops (pineapple, star fruit, melon, among many more) to export.
- Provide technical support teams that can help to organize producers in a group with centralized administration (cooperative/organization) and assist them comply with legal requirement (certification, quality standards, organizational skills and exportation requirements).
- Technical support for transition models (conventional to organic).
- Avoid over production of crops. Produce based on the needs of the different markets: local, processing and exporting goods. Methodological assistance from buyer/importer to design a programmed production on the farms. Monthly plan for planting and harvesting quantity, along with other technical aspects of the farm design including nutrient budgets and input use records.
- Integrate social sciences and embrace different ideas and new customs. This can help guide a project in terms of how to organize and integrate producers and consumers into farming and innovations systems.

New Design

- Crop Zoning: Specializing the different producers according to the different crops that are best produced in the different pedoclimatic conditions. The ministry of agriculture was suggested as being able to facilitate the implementation of this type of project.
- Main crops of interest for external and internal markets are: pineapple (*Ananas comosus*), ginger (*Zingiber officinale*), star fruit (*Averrhoa carambola*), passion fruit (Passiflora edulis), curcuma (*Curcuma longa L.),* sweet potato (*Ipomea batatas*), cassava (*Manihot esculenta*), coconut, lemon (*Citrus limonum*), papaya (*Carica* papaya*)*, squash, arlum melons (*Cucumis melo*), with possibilities to introduce new exotic crops of the international market demand.
- Two designs were of special interest for the producers. The first one is an agro ecological design of bigger areas (0.5-1 ha) with rotational alternatives of different crops. These designs are especially intended for farmers that use mechanization in their farm. This tendency is for farmers, who usually have bigger areas and hire extra labor for planting, harvesting and other tasks. The second design is an intercropping system, which includes many crops in a more detailed planning. Both systems embrace in their design key improved agronomic practices such as: use of compost, microorganisms, crop rotation, green compost, hedges of legumes, and other agro ecological practices.
- Exportation and organization guidelines for producers especially for maintaining quality standards required for the different markets.. Taking into account methods that can allow producers to learn and share this knowledge between them.
- Important actors have been identified as participants in the re-design of the new business models.

Farmers need support to find solutions to their problems starting with the mapping of their interests as related to specific production techniques, crops, and concerns among many other characteristics that would be incorporated in new systems that address their needs and share holders of the whole sector.

Organization and need for transparency in transactions

There is need to advice farmers on how to organize themselves in a structured manner that will allow them to benefit from economies of scale in terms of production, training, and certification. This requires proper organizational structure and management techniques so they can learn and as a group evolve as an independent organization. This applies mostly to small and medium producers, which are part of the cooperatives. At this point, it is essential for producers to have knowledge about marketing, production, legalities, and negotiations among many other skills and training required in order to be successful in their daily operations and business. It is crucial for the functionality of a group of producers to identify the necessary tools to function as an organization It has been well known that there are some problems in cooperatives in Costa Rica; this should be further analyzed thoroughly to learn from past mistakes and work with people with experience handling organic groups and farms successfully (certification / inspectors / individual producers/ etc.)

Co- Innovation and Technology Transfer

For the pineapple sector there are many areas to be improve when it comes to agricultural practices. Several studies conducted in Costa Rica focus on the environmental problems associated with poorly managed pineapple production systems. New investigations are needed to address organic production problems and to develop suitable solutions to these problems. The aim would be to create an innovation environment that enable generation of applied knowledge and suitable production techniques that can help support successful production system that comply with key sustainability requirements. Discussion of these various issues found during the first stage want to be discussed and overviewed to find ways to carry out studies and research proposals.

.

6.3 Research - Opportunities for improving production systems

It is evident that there is a need for research in organic pineapple production. If producers aim to evolve towards more sustainable production systems they will need support or incentives to be successful during the transition. This in order to implement the required changes in their farms. Producers of intensively managed farms thus may have to invest in improved inherent soil structure and fertility, making use of a combination of different management strategies and technical interventions presented above.

Producers experiment as part of farming and are "learning by doing" and in this way farm management skills and production techniques evolve continuously through a "learning selection" mechanisms. Nevertheless, small farmers are increasingly confronted with situations for which previous experience provides limited guidance. At this point, researchers can play a role in supporting the intrinsic learning capabilities of farmers so that they can make better-informed decisions by helping them manage the complexity of their farms and adapt current practices to emerging conditions. Throughout the DEED process researchers interact closely with stakeholders and also learn by analyzing current situations and prevailing practices and actively consult with local actors when identifying desirable futures and plausible outcomes. Use of system design tools can reinforce this process by allowing researchers to analyze many farm structures and corresponding management practices that farms represent. Such innovation processes appear to be more effective when also involving actors from the wider farmer network, including government support, suppliers, retailers, and policy makers (Rossing, 2010).

Based on this premise, it is essential to identify actors involved in organization and evaluation of the project. An outline of some of the actors that have been identified to be supportive and involved in the project is outlined in Annex 3. Meetings and workshops have to be carried out with different actors, which might be involved during the future implementation of this project.

Large producers are perceived to be less interested in participating in sharing of knowledge and are also less inclined to change in their production schemes. The conventional producers are not interested in any kind of diversifying production schemes including pineapple being part of a larger crop rotation. However, they did show an interest in investigations that can help to improve current production systems including composting as a means for residue management, bio repellents for different plagues, among others. They produce large amounts of quality pineapple; they do not see small quantities of diversified products to be a viable alternative for the current status quo. Besides this they are not interested in engaging in a possible alliance with small organic producers for producing and packing special commodities. Large organic farms do not experience much competition from small-scale producers. Even though they produce large volumes, their production costs are still much higher than conventional, which makes organic pineapple a very challenging business model for monoculture farms. All farmers showed an interest in the transfer of technology and the exploration of more sustainable and economically feasible production techniques and management strategies. Large producers seemed uncomfortable to share and/or transfer technologies because they prefer to keep a competitive edge.

Medium size farmers expressed mixed feelings about these schemes. They like to explore the possibility of including other produces in their planting systems, to assure more monetary stability. However, they are a bit skeptic about the organization of such systems and the structuring of required distribution channels. Some showed interest in participating in future pilot studies to further explore such systems or business plans. They seemed more open to technology transfer between producers compared to large producers. Also they are in more secure position in terms of prices and marketing, which is an advantage over smaller growers. Since they manage smaller areas it may also be more easy to manage more different crops at the same time. These hypothesis could not be verified and thus warrant further investigations.

Small farmers were very interested in new business plans, since many have failed to overcome the pineapple crisis during the past years. However, they have lost trust in the sector and also in the governmental institutions, commercial companies, and research institutions including Universities. They stated that the only reason to participate would be if they were assured of good prices and secure international sales. It has been identified that they would need help in many organizational aspects including certification, quality produce assurance, price negotiation, sustainable production practices and producer's organization for export.

7. References

Acuña, G. 2004. *Diagnostic situation and conditions of the pineapple industry: Characteristics, organization and labor conditions*. ASEPEROLA (Asociación servicios de promoción laboral).

Acuña, G. 2006*. Producción de piña en Caribe y Pacífico Sur de Costa Rica.* Ambientico, 158. Universidad Nacional (UNA), Heredia, Costa Rica.

Alvarez, S., Paas, W. , Descheemaeker, K., and Groot, J. 2014. Workshop 11-13. *Constructing typologies, a way to deal with farm diversity: General guideline for Humid Tropics*. Plant Science Group, Wageningen University, Netherlands.

Alvarez- Lopez, C., Riveiro J. , Marey, F. 2008. *Typology, classification and characterization of farms for agricultural production planning*. Spanish Journal of Agricultural Research.

Aravena, J. 2005. *La expansión piñera en costa rica la realidad de los perdedores de la agroindustria exportadora de la piña.* COECOCeiba. Available at: coecoceiba.org/wp-content/subidas/2010/03/pub11.pdf

Astier, M., L. García-Barrios, Y. Galván-Miyoshi, C. E. González-Esquivel, and O. R. Masera. 2012. *Assessing the sustainability of small farmer natural resource management systems. A critical analysis of the MESMIS program*. (1995-2010). Ecology and Society 17(3): 25.

Banacol. 2011.*Estudio de Caso: Evaluación del sistema de producción de piña (Ananas Comosus L. Merr.) y la implementación tecnológica de buenas practicas agrícolas integradas en la Región Huetar Norte y Nor- atlántica de Costa Rica*. Proyecto GEF-REPCar.

Barrientos, O. and Chaves, G. SEPSA and PROCOMER. 2008. Región huetar norte: oferta exportada actual y oferta potencial de productos agropecuarios alternativose productos agropecuarios alternativos. Available at: http://www.procomer.com/contenido/descargables/investigaciones_economicas/2008/Region_Huetar_Norte_final.pdf

Barrientos, O. 2010. Sector Agropecuario: Cadena productiva de piña políticas y acciones. SEPSA (Secretaria ejecutiva de planificación sectorial agropecuaria) y MAG (Ministerio de Agricultura) San José Costa Rica.

Best, H. (2008). *Organic agriculture and the conventionalization hypothesis: A case study from West Germany*. Agriculture and Human Values, 25(1), 95-106.

Blazy, J. et al. 2009. *A methodological framework that accounts for farm diversity in the prototyping of crop management systems*. Appication to banana-based systems in Guadeloupe. Elsevier. Agricultural Systems. 101. 30-41.

Bremmers, H., Trienekens, J. H., van der Vorst, J. G., & Bloemhof, J. M. (2011). *Systems for sustainability and transparency of food supply chains–Current status and challenges.* Advanced Engineering Informatics, 25(1), 65-76.

Brenes, L. 2011. *Developing a Small Grower Based Organic Pineapple Export System. Agrivita and Proagroin*. Available at: http://www.pnp.cr/investigaciones.php

Calderon, J. et al. 2013. *Estadísticas de Comercio Exterior de Costa Rica 2012. PRCOMER (Promotora del comercio exterior de Costa Rica.)* San José, Costa Rica ISSN: 2215-2342.

Cartin, S. and Piszk, I. 1980. *La producción de granos básicos en Costa Rica: Instituciones estatales y fuerzas sociales periodo de diversificación económica.* Cienc. Soc. 19-20:25-35.

CANAPEP (CamaraNacional de Productores y Exportadores de Piña) Costa Rica.Available at: http://www.canapep.com/pina-de-costa-rica/historia

Costa Rican News Teletica, March 2013 Article from local newspaper. La Nación pg 20A. Published on the 20 th of June 2013. Costa Rica. Available at: http://www.teletica.com/Noticias/5108-Asamblea-Legislativa-investigara-a-Proagroin-tras-denuncias-de-cientos-de-pineros.note.aspx.

Daskalopoulou I. and Petrou, A. 2002. Utilizing a farm typology to identify potential adopters of alternative farming activities in Greek agriculture. Journal of Rural Studies (2002) 95-103

Sakane, N., Becker, M. and Langensiepen. 2013. Typology of Smallholder production in Small East-African Wetlands. Society of Wetland Scientists. 33:101-116.

Dogliotti, S., et al. *Co- Innovation of family farming systems: a systems approach to sustainable agriculture.* Agr.Syst. (2013) Available at: http://dx.doi.org/10.1016/j.agsy.2013.02.009

Diaz, S. 2013. *El Dulce y amargo sabor de la piña*. El Financiero Newspaper. San Jose, Costa Rica

EOSTA and ICCO, 2010*. Sustainability of organic & organic –fairtrade pineapple growing for export*. ICCO & EOSTA Mission Report. Available at Nature and More website: http://www.natureandmore.com/search?portal_type=Blog+Item&portal_type=Grower&portal_type=Product&portal_type=Standard+Page&SearchableText=ICCO

Emanuelli, M., Jonsen, J. and Monsalve, S. 2009. *Latin America reports on monoculture and violations of the human rights to adequate food and housing, to water to land and to territory*. FIAM Sweden and SAL. FIAN International, Sweden.

Guadarrama, C. 2008. *A grower typology: Approach to assessing environmental impact of coffee farming in Veracruz, Mexico*. 2008. WUR Library Available at: http://books.google.nl/books?hl=nl&lr=&id=BbGTuQEQ0kMC&oi=fnd&pg=PA127&dq=farm+typologies+in+costa+rica&ots=G-pBdvnomN&sig=1-c_DvF1NXnvcQ36SRS9674J8hE#v=onepage&q&f=false

FAO Corporate Document Repository. Participatory survey methods for gathering information. Technical Cooperation Department Available:http://www.fao.org/docrep/w8016e/w8016e01.htm#knowledge,%20attitude%20and%20practice%20surveys

Faure, G and D Meneses, 2002. *The Farm in the region Huetar Norte: and evaluation of actual conditions of the farms of family producers*. CIRAD Francia and MAG (Ministry of agriculture Costa Rica.)

Faure and G. and Samper, M. 2004. *Veinte años de apertura económica: El porvenir comprometido de la agricultura familiar en el norte de Costa Rica*. Anuario de Estudios Centroamericanos, Universidad de Costa Rica , 30 (1-2)7-26, 2004.

Gauggel, C. *Programa de Conservación de suelos en el cultivo de la piña (Pineapple Program for soil conservation).* Presentation for pineapple producers in offices of Dole, Costa Rica. International Director of Soil Management.

Giller, K. E. et al. 2008. *Competing claims on natural resources: what role for science.* Ecology and Society 13(2): 34. [Online] URL: http://www.ecologyandsociety.org/vol13/iss2/art34/

Groot, J. 2013. Analysis and Design of Farming Systems Course, Wageningen University.

Guinot, C., Latreille, J., Malvy, D., Preziosi, P., Galan, P., Hercberg, S., & Tenenhaus, M. (2001). *Use of multiple correspondence analysis and cluster analysis to study dietary behaviour: food consumption questionnaire in the SU. VI. MAX.* cohort. European journal of epidemiology, 17(6), 505-516.

Hayati, D., Ranjbar, Z. and Karami, E. 2011. *Measuring Agricultural Sustainability.*

Department of Agricultural Extension and Education, College of Agricultural Shiraz University, Shiraz, Iran. Springer article. ISBN: 978-90-481-9512-1.

Holdridge, L. R.: 1947, '*Determination of World Plant Formations from Simple Climatic Data*', Science 105. 367–368.

Ingwerse, W. 2012. *Life Cycle Assessment of fresh pineapple from Costa Rica.* Elsevier. Journal of Cleaner Production 35 (2012) 152-163.

Kellon, D., R. León, and R. Marsh. 2011. *Pineapple producer perspectives and policy implications to promote ecologically sustainable production of pineapple in Costa Rica.* Ecoagriculture Report. Washington, DC: EcoAgriculture Partners with EARTH University. Available at: http://www.pnp.cr/backend/files/catalogo/4999_Perspectivas%20de%20los%20productores%20de%20pi%C3%B1a%20e%20implicaciones%20pol%C3%ADticas%20para%20promover%20la%20producci%C3%B3n%20sostenible%20de%20pi%C3%B1a%20en%20CR-2011_bib.pdf.

Landais, E., 1998*. Modeling farm diversity: new approaches to typology building in France.* Agricultural Systems 58, 505 527.

Lopez-Ridaura, S. Astier, M. and O. Masera. 2002. *Evaluating the sustainability of complex socio-enviromental systems*. The Mesmesis framework. Ecological Indicators, Elsevier Sciense Ltd.

López-Ridaura, S., van Keulen, H., Van Ittersum, M.K., and Leffelaar, P.A., 2005. *Multiscale Methodological Framework to Derive Criteria and Indicators for Sustainability Evaluation of Peasant Natural Resource Management Systems*. Environment, Development and Sustainability 7, 51-69.

Mądry, W., Mena, Y., Roszkowska-Mądra, B., Gozdowski, D., Hryniewski, R., & Castel, J. M. (2013). *An overview of farming system typology methodologies and its use in the study of pasture-based farming system: a review.* Spanish Journal of Agricultural Research, 11(2), 316-326.

MAG, 2010. *Estudio del estado de la producción sostenible y propuesta de mecanismos permanentes para el fomento de la producción sostenible*.GFA Consulting Group S.A. Available at: http://www.mag.go.cr/bibliotecavirtual/a00186.pdf

Maglianesi, M. 2013. *Desarrollo de las piñeras en Costa Rica y sus impactos sobre ecosistemas naturales y agro-urbanos*. Biocenosis Vol. 27 (1-2). UNED , Costa Rica.

Peña, M. 2011. *Gestión de riesgos ambientales del sector financiero relacionadas con* *sus carteras agrícolas de piña*. Available at: http://www.pnp.cr/backend/files/catalogo/2323_Gestion%20de%20Riesgos%20Ambientales%20del%20Sector%20Financiero.pdf

Pomerada, C. *WTO agreement on agriculture: the implementation experience...* Study prepared for FAO. San Jose, Costa Rica. Produced by: Economic and Social Development Department

PROAGROIN Website: http://www.procomer.com/contenido/proagroin.html

Quijandría, G ., Berroca J. and Pratt, L. Julio 1997. *La Industria de la Piña en Costa Rica Análisis de Sostenibilidad.* INCAE. Available in : http://www.incae.edu/es/clacds/publicaciones/pdf/cen707.pdf

Ramirez, R. and Muñoz, J. 2007*. La reforma económica y su impacto social en Costa Rica durante el período de ajuste estructural: Apuntes críticos para el análisis*. UNA (Universidad Nacional de Costa Rica). Economía y Sociedad No 31 and 32. Pg. 5-34.

Richardson, R. et al. 2013. *Using choice experiments to understand household tradeoffs regarding pineapple production and environmental management in Costa Rica*. ELSEVIER. Journal of Environmental Management. 127. 308-316

Rossing W., 2010 et al. *Project design and management based on a co-innovation framework: towards more effective research intervention for sustainable development of farming systems.* 9th European IFSA Symposium, Vienna Austria.

R Core Team (2012). R: A language and environment for statistical computing. R Foundation for Statistical Computing. Version 2.14, Vienna, Austria. URL : http://www.R-project.org/

Russo, R. et al. 2006. *Prospective impact analysis of the growth pineapple crop area in the Atlantic Region of Costa Rica*. Proc. Fla. State Hort. Soc. 119:1-3. Available at :http://www.pnp.cr/investigaciones.php

Speelman, E. N., Astier, M., López-Ridaura, S., Masera, O. R., & Gonzalez-Esquivel, C. E. (2011). *Sustainability indicators, alternative strategies and trade-offs in peasant agroecosystems: analysing 15 case studies from Latin America*. International Journal of Agricultural Sustainability, 9(3), 409-422.

Tittonell, P. et al 2009. *Beyond resource constraints- Exploring the biophysical feasibility of options for the intensification of small holder crop-livestock systems in*

Vihiga district, Kenya. Agricultural Systems 101 (2009) 1- 19.

Trienekens, J. 2007. *Los estándares de calidad y seguridad en la cadena alimentaria internacional.* Distribución y Consumo 21. Wagenigne University, Netherlands.

United Nations: Comisión Económica para América Latina y el Caribe(CEPAL) 2009. *Crisis de los precios del petróleo y su impacto en los países centroamericanos.* Available at: http://www.cepal.org/publicaciones/xml/8/36328/L908.pdf

Villegas, O. et al. 2007. MAG (Ministerio de Agricultura y Ganadería. Dirección Regional Huetar Norte. 2007. *Caracterización y plan de acción para el desarrollo de la agro cadena de piña en la región Huetar Norte.* Cuidad Quesada, Costa Rica. Available in: www.pnp.cr/backend/files/.../2645_MAG-DRHNORTE-2007bib.pdf

Waney, N.F.L, Soemarno, Yuliaty, Y. and Polii, B. 2014 *Developing Indicators of Sustaiable Agriculture at farm level.* IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) e-ISSN: 2319-2380, p-ISSN: 2319-2372.Volume 7, Issue 2 Ver. II (Mar-Apr. 2014), PP 42-53 www.iosrjournals.org

Willer, et al. 2009. T*he World of Organic Agriculture. Statistics and Emerging Trends 2009*. FIBL-IFOAM Report. IFOAM, Bonn; FiBL, Frick; ITC, Geneva .

8. Annexes

Annex 1. Questionnaires for small producers

Target group:
Questionnaires for small to medium pineapple farmers (farms 1 – 80 ha, no large Corporations).

Rationale:
This questionnaire will be used to make an inventory of the current situation of pineapple growers in the region Huetar Norte. Information obtained will be used to structure solutions related to key focal aspects of this research. By analyzing results a farm typology will be developed which helps to learn about each type of farmers and their main issues and concerns. This questionnaire is a first step to identify representative farmers within farm groups that share common farm features. Once such farms are identified they will be used to study farm characteristics and underlying processes more in depth using simulations and other analytical programs.

Interview N° ______________________ Date:_______________

Name Interviewer: _________________________

Location Farm: ___________________________________

A. General Information

Name respondent: __________________________ Age:____ Gender: F or M

Responsible household: Yes or No

How many family members live in the farm? N° ________________

Female _______ Ages: _________ Work in farm : Yes or No / Hours:______
Male __________ Ages: __________ Work in farm: Yes or No / Hours:______

Do you work in another job besides the farm? Yes or No

If yes how many hours: _________ What occupation? __________________________

Is your mayor income dependent on the farm profit? Yes or No.

B. Farm Specifications

1.) Cultivated land ________________ (ha) / Total land ___________(ha)
Plant Density: ___________________________plants /ha

Organic Certified / Conventional / Low Input

Crops	ha	Rented	Owned	Cost /ha	Other	Characteristics

2.) Livestock

Type :_________N° _____________ Feed Source:___________________________
Type :_________N° _____________ Feed Source:___________________________
Type :_________N° _____________ Feed Source:___________________________

3.) Soils

Soil Type:
Clay Loam / Clay / Sandy Loam Clay / Sandy Clay
Other:

Have you ever done any soil test? Yes or No . If yes how often:_____________

4.) Soil Amendments

Type*	S*	OA*	C*	Amount (kg/ha)	Cost /ha	Frequency	Method of Application*	Active Ingredients	Other Information (Other application amounts)

*Type: Compost / Farm Yard Manure / Lixiviates/ Liquid Fertilizer or Granulate / Legumes
*S: Synthetic Fertilizers. Mark with an X.
*OA: Organic Approved fertilizers. Mark with an X.
*C: Created in farm. Mark with an X.
*Method: Hand Application, Tractor or Fumigation

5.) Do you prepare any compost or home made fertilizers? Yes or No

If so what ingredients do you use: ____

What kind of storage:

Uncovered /Covered   Stable / Outside/ Pit   Ground /Cement   Pile / No pile

Other observations: ____

6.) Do you grow any cover crops/ legume trees/ legume crops? Yes or No .
If yes what kinds: ____

7.) What do you think of your soil fertility?

Very Good   Good   Moderate   Bad   Very bad

8.) Do you see any difference from now or 10 years ago?   Yes or No
For: Good or Bad

9.) Since you started planting pineapple as a monoculture do you see a difference or increase in:

Soil Fertility: Less / More / Same

Erosion: Less / More / Same

SOM: Less / More / Same

Water Infiltration: Less / More / Same

Cash Crops (Pineapple): Less / More / Same

10.) What kind of tillage do you use?

Animal tillage / Conventional / Low tillage / No till

11.) In pineapple fields how many passes are done with the machine?

Terrain preparation:
Input Application:
Harvest:
Others:

Other crops: ______________________ Passes: __________________________

12.) Application of Inputs

Type*	S*	OA *	C*	Amount (kg/ha)	Frequency	Method of Application*	Cost / ha	Other Information

*Type: Herbicide / Fungicide/ Lixiviates/ Insecticide/ Other
*Method: Hand Application, Tractor or Fumigation

If only produce pineapple this part can be skipped from questionnaire.

13.) Do you practice any crop rotation or intercropping system with the pineapple?
Yes or No.

If yes what crops are included in the crop rotation and is there a preferred sequence?

Crop	Cropping System*	Destiny*	Frequency planted	Further Information (Preferred sequence)

*Cropping Systems: Rotated / Intercropped. Explain in further information
*Destiny: National Market/ Export / Self Consumption

Do you practice any of the following techniques in your farm? If not give a reason.

Technique	Yes	No	Reason
Mulching Practices			

Green Manures or compost			
Integrating other crops			
Crop Rotations			
Agro forestry			
Minimize chemical input			
Create own fertilizer /bio pesticides			
Producer Support Systems*			

*Producer Support Systems: Working in farmer support groups to share technologies and work together for marketing products.

C. Social Aspect: Networks, Farm Resources and Training

1.) Do you hire any workers? Yes or No. Temporary __________ / Fixed_________.
Temporary For: Planting / Harvesting / Farm Chores

If yes how many people: ________________. Price paid by hour: ________________.

What is your yield per ha:________________________
1st quality (export) % per ha _________________________ price /ton________________
2nd quality % per ha __________________________________price /ton________________
What is your cost per ha:__________________________

2.) Where do you get your technical support and information?

Neighbors / Supply Companies / MAG / Other: _________________________

Have you been part of any extension or training program? Yes or No.

If yes please specify:

Type of training	Times	Year & Duration	Organized by

3.) Have you ever been part of a technical support group in your community for pineapple production or other crops?

Yes or No. If yes, what kind:____
____

4.) Do you share knowledge with your neighbors? Yes or No. Give an example:
____

5.) Do you form part of any cooperative or producers association? Yes Or No.

If yes give names: ____

If no, would you be interest in a project implementation for:

Project	Yes	No	Reason
Organic Certification			
Selling to external markets like EOSTA. Selling to internal markets like fairs and supermarkets.			
Integrating other crops like: lemons, cassava, sweet potato, passion fruit, ginger, and others.			
Receiving technical assistance through the process. Working together to implement a new marketing strategy and producer's support system.			
Being part of a pilot plan, created specifically for producers to convert to organic slowly.			
Creating new policies of incentives for more ecological and good agricultural practices.			
Supporting a new policy making involving different actors of the chain: retailers, supermarkets, importers, exporters, Government, NGO´s, etc.			
New technologies like: legume integration, intercropping, compost, mulching, green manures and crops for self-consumption.			

6.) What are the mayor issues you identify in your farm?

Issues	Yes	No	Why do you think it happens	Possible Solutions for the Future

Soil				
Diseases				
Labor Intensity				
Selling & Distribution				
Cost: Benefit				
Competition				
Quality Standards				
Others				

D. Market and Distribution

Where do you sell your product? Internal Market or Export.
If you sell in the internal market, where or to whom you sell your product:______________________________
What price do you get per/kg of pineapple: ______________________
Other crops:

How do you pack or distribute your product:

Bulk distributed in your car / Packed in boxes ready for export

If you export, do you own or rent a packing station? Yes or No.
If you sell to a distributor, what company:____________________________

Do you have a contract? Yes or No. Do they give you a fixed price: Yes or No

Price of kg/pineapple: __________________

Are you happy? Yes or No. If No why?______________________________________

____

Annex 2. Problem Trees

The problem trees were created from the data collected during previous stages of the investigation, were used in the workshops as an important tool to overview all of the known causes and effects of the identified problems, and how they are interconnected. The problem trees were separated into three categories: big conventional producers, small holders, and organic producers.

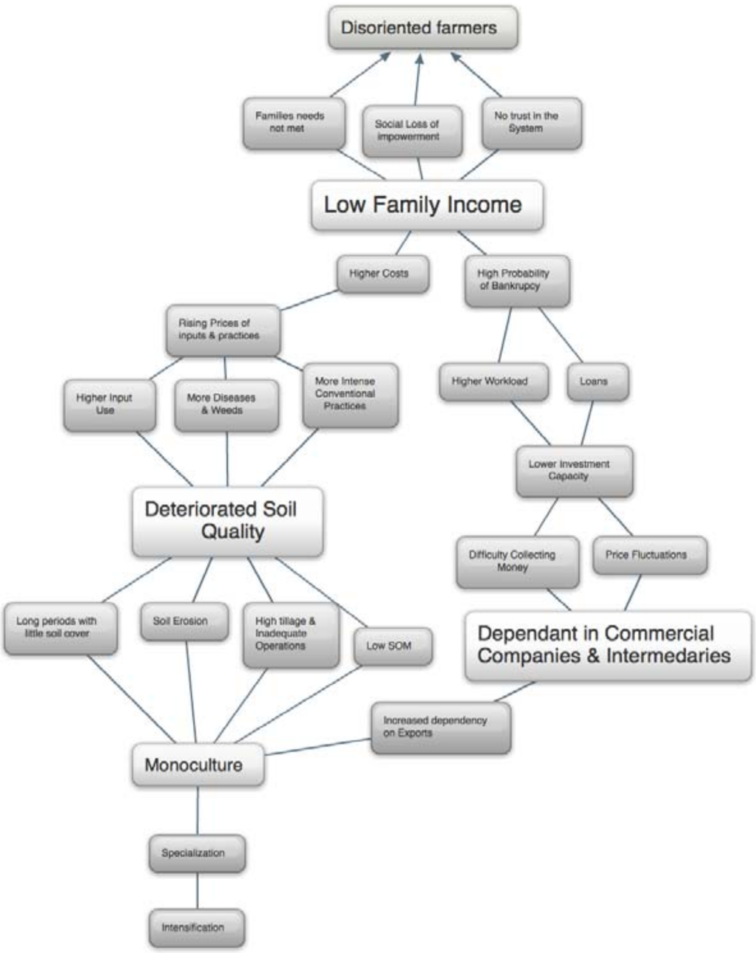

Figure 23. Problem tree summarizing main problems defined by small pineapple producers of the RHN. The boxes with lighter grey represent the main problems of the farmers identified in the interviews.

In figure 23 it is shown how the problem trees highlighted several and important common problems and consequences for the small holders performance in their farms. The green boxes contain the main problems identified by most of the farmers during the meetings and interviews, listed below:

1. Market and counseling
2. Commercial Companies and intermediaries
3. Prices- Uncertainty
4. Difficulty to collect payments
5. Financing
6. Credibility toward buyers- called phantoms (Interview President Coopepiña Leonidas Chaves, October 2013)

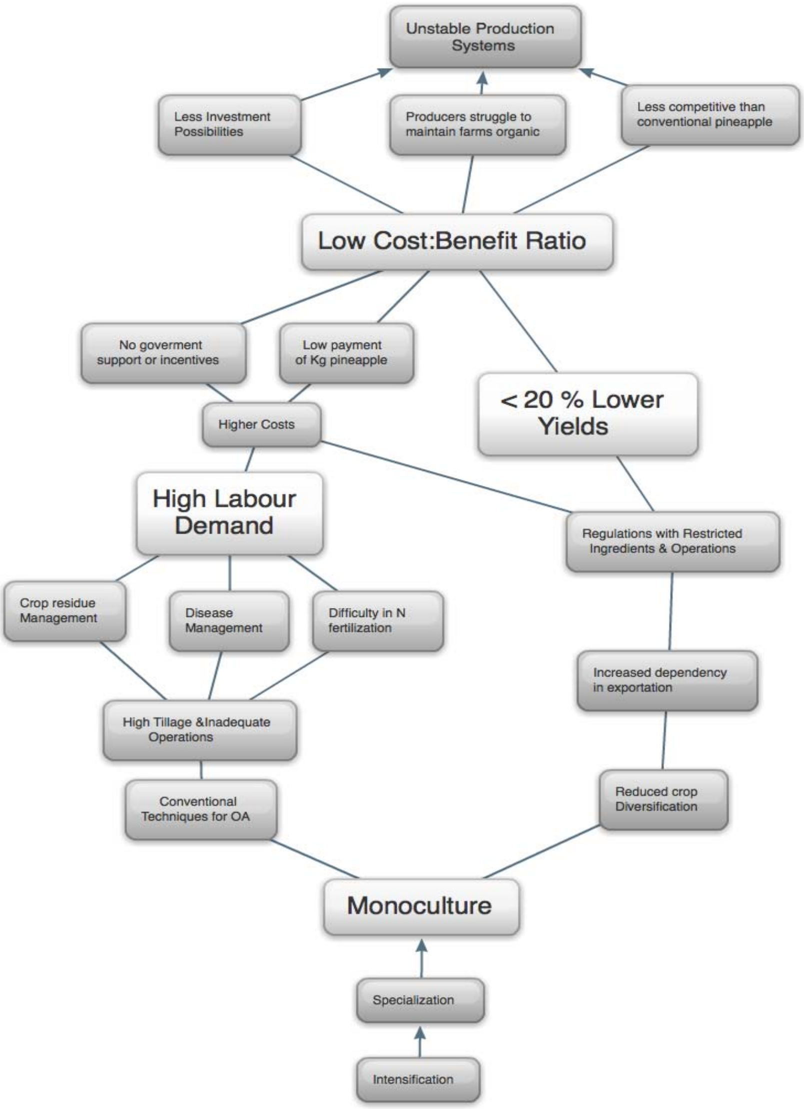

Figure 24. Problem tree summarizing main problems identified by organic pineapple producers (medium to big) of the RHN. Light grey boxes represent the main problems of the farmers.

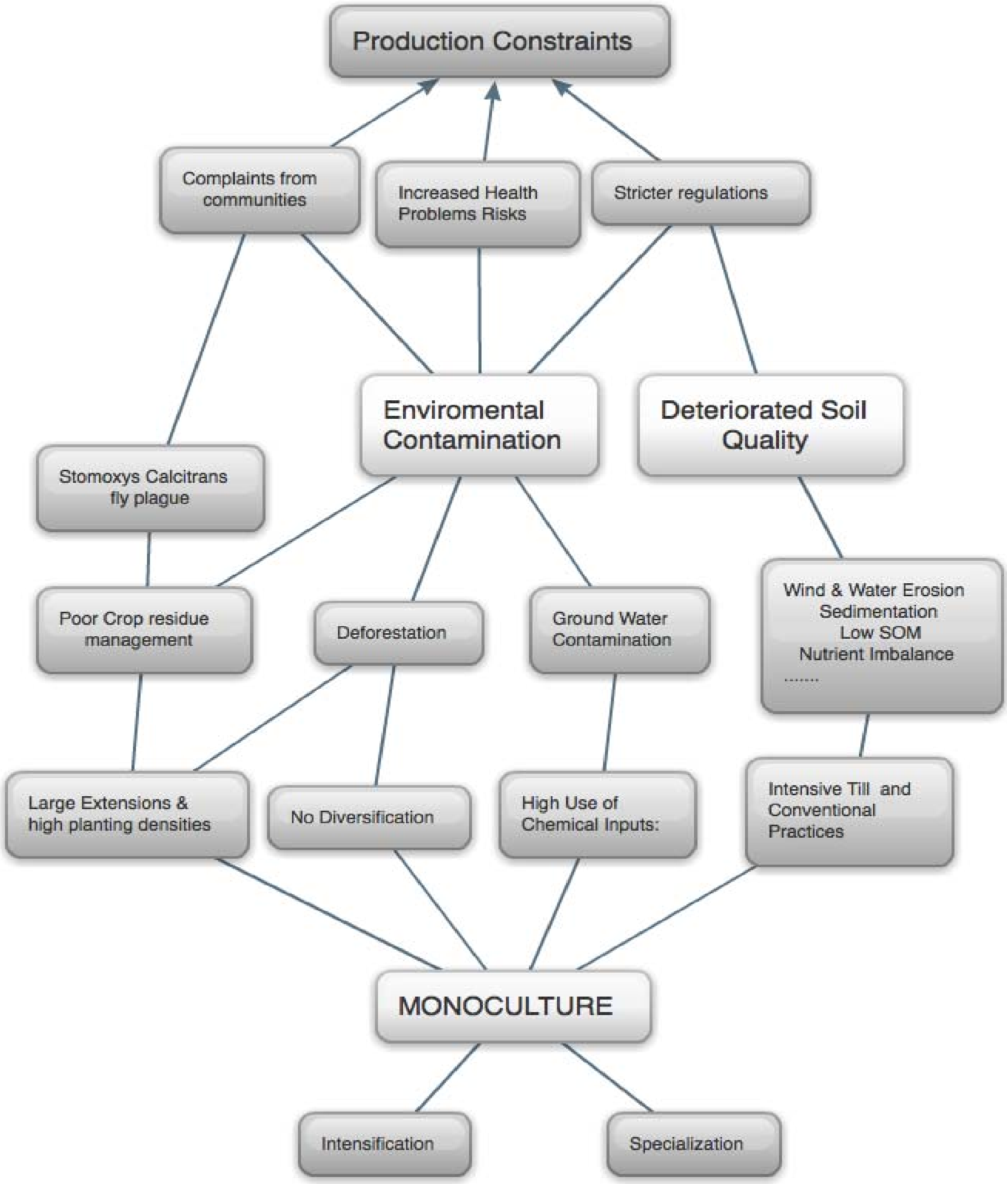

Figure 25. Problem tree summarizing main problems defined by conventional pineapple producers (medium to big) of the RHN. Light grey boxes represent the main problems of the farmers..

Annex 3. Work shop Agenda

Schedule	Activity	Methodology	Materials	Coordinator	Result
9:00-9:30am	Introduction to the Agenda	Provide a brief power point presentation as an introduction. Each person will have a copy of the agenda. Tables according to color groups, which each person will be granted, previously. Wanted groups will have players who can contribute to finding solutions to each other. Markers and ballots for Workgroups surrender.	-Agenda printed -Projector -Big papers -Markers	Maria Pia Gamboa	Submit actors day schedule. Delivery of material.
9:30-10:30 am	Problem trees Presentation	1. Trees are presented in a power point presentation. Then comments or feedback changes would be made.	- Projector	María Pia Gamboa	Share the results found during the first phase of research. Confirmation of effects and causes of problem trees by the producers, these reflect reality?
10:30-10:45am	COFFEE BREAK				
10:45-12:00am	Solutions Round-Table present results discussion	1. Subsequently be separated into different groups. It would give between separate groups: large producers, small, and medium. These workshops will be to find the best solutions for the problems in order of importance. They seek to find who might be responsible, who can support them and a period to implement these solutions. 2. Presentation and discussion with everyone present.	-Markers and big papers	Moderator: María Pia Gamboa	
12:00-12:30	Introducing new possible production designs	Short presentation of the plans and important actors. Share EOSTA commitment and the University of Wageningen in the project and interest in research, training and future producers find they can handle organ systems to sell organic produce to the company.		María Pia Gamboa	Describe the plan for future research and potential business plans organic productions.
12:30-1:30pm	LUNCH				

1:30pm-2:15pm	Introducing new possible production designs Second Part	Power point presentation of possible future production designs. At least 3 productive designs in order to receive feedback from farmers is presented. You need to receive all relevant observations to achieve in the future do a business plan suitable for producers and importers. Systems that meet quality, capacity and diversity necessary.	-Markers and big papers	María Pia Gamboa	Receive feedback of producers and actors. As the project you may be interested and organic production process and know which crops are comfortable. Production management and organization of producers.
1:45-2:15pm	Interest and research needs. Organic and conventional Sector	Presentation and introduction of the first research topic planned via this project. Compost and organic fertilizers through waste residue of pineapple.		María Pia Gamboa and Fabián Calvo a senior at EARTH University	Discussion of the need for research in the field, mainly in organic issues that can influence in finding more sustainable solutions for all sectors. Discuss and present possible research topics to improve the pineapple production or alternative mentioned in the project.
2:15-2:30	CLOUSURE & QUESTIONS				

Annex 4. Work shop Attendants

Name	Organization/ Institution	Stakeholder Position
Xinia Solano	MAOCO/Organic	Organic Producer
Carlos Víquez	Organic Producer	Organic Producer
Andrés Núñez	General Manager Coorsicana Pineapple Farm	Organic Company Producer
Rigoberto	Input Manager Coorsicana Pineapple Farm	Organic Company Producer
Fabián Calvo	EARTH University 4 th year student	Investigator
Walter Rossing	Universidad Wagenignen FSE Group	Investigator
Juan Carlos Arias	Representative of EOSTA in Costa Rica	Exporter
Henk Zoutwelle	Buyer of Pineapple for EOSTA in the Netherlands	Importer
Daniel Herrera	Organic Producer- EARTH University	Producer
Alberto Chinchilla	Organic Consulter L.A	Organic Producer
Arturo	PITTA Piña	Investigator

Solórzano		
Josef Bier	Finca Luna Nueva- Organic Farm	Investigator
David Meneses	MAG Pital	Governmental Institution
Juan Luis Rojas	Coopepiagua- Guatuso	Conventional Producer from Cooperative
Leónidas Chaves	Coopepiña- Pital	Conventional Producer from Cooperative
Yoriely Villalobos	AgroFair	Dutch Importer Company
Luis Carlos González	SOGO Piñas	Organic Producer
Pia Gamboa	Wageningen University	Coordinator - Investigator

Annex 5.Results from R program- Box Plots and Factorial Maps

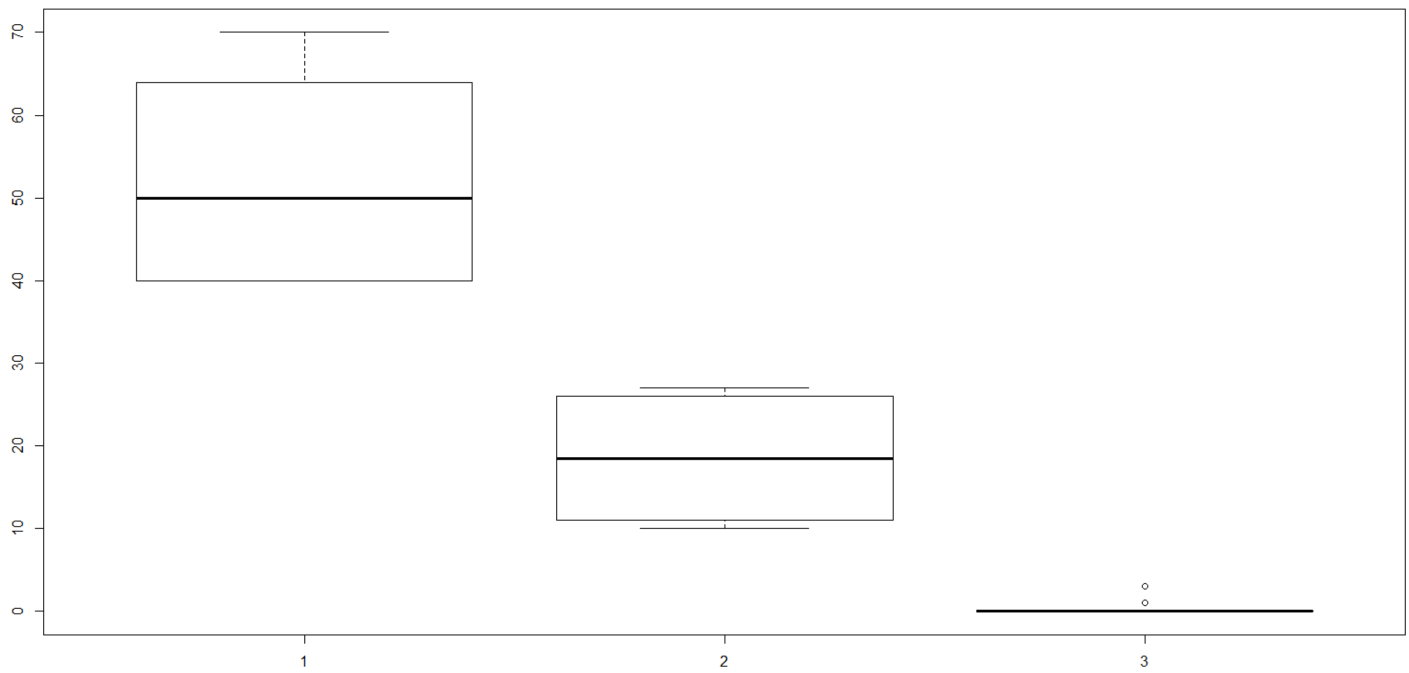

Figure 26. Box Plot for modalities of the variable Cattle.

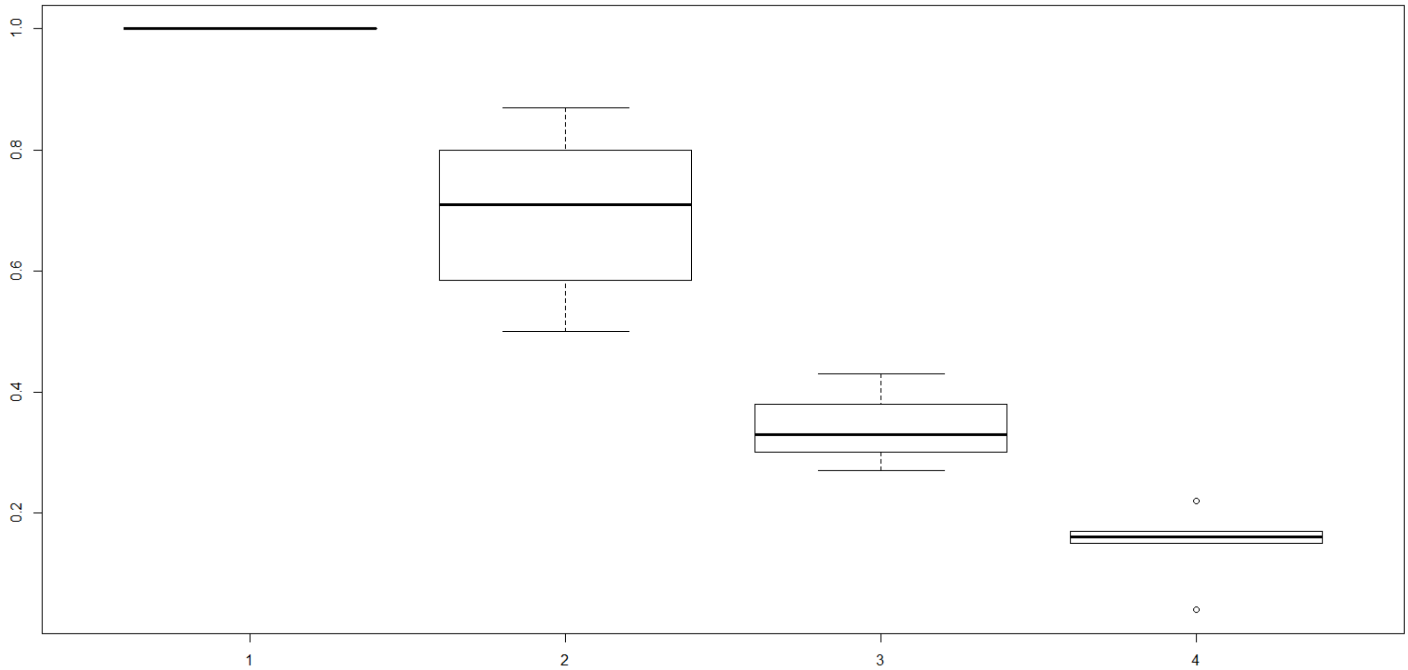

Figure 27. Box Plot for modalities of the variable Cultivated Ratio.

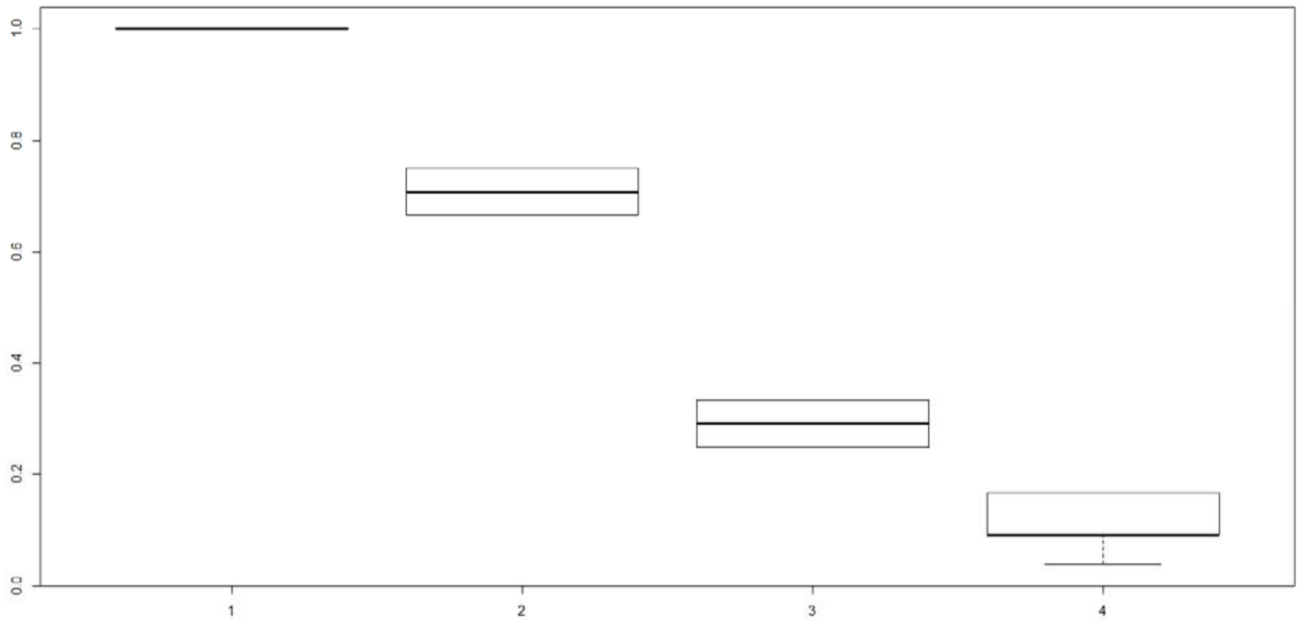

Figure 28. Box Plot for modalities of the variable Famratio.

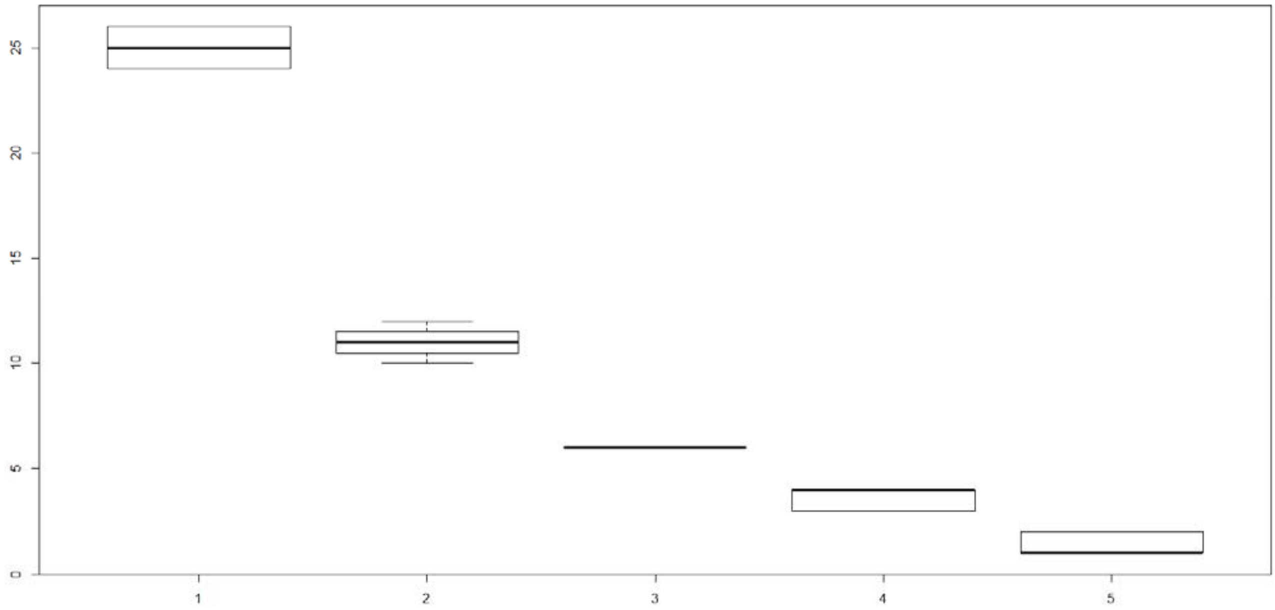

Figure 29. Box Plot for modalities of the variable TotFixLabor.

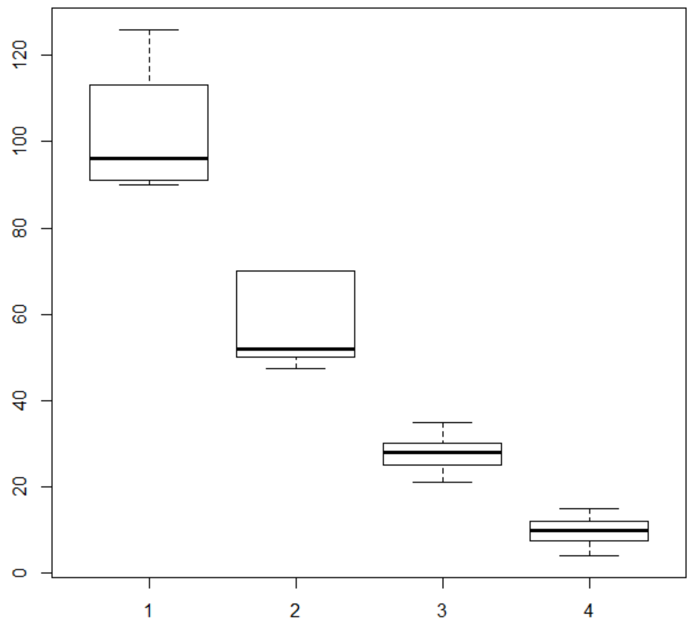

Figure 30. Box Plot for modalities of the variable TotLand.

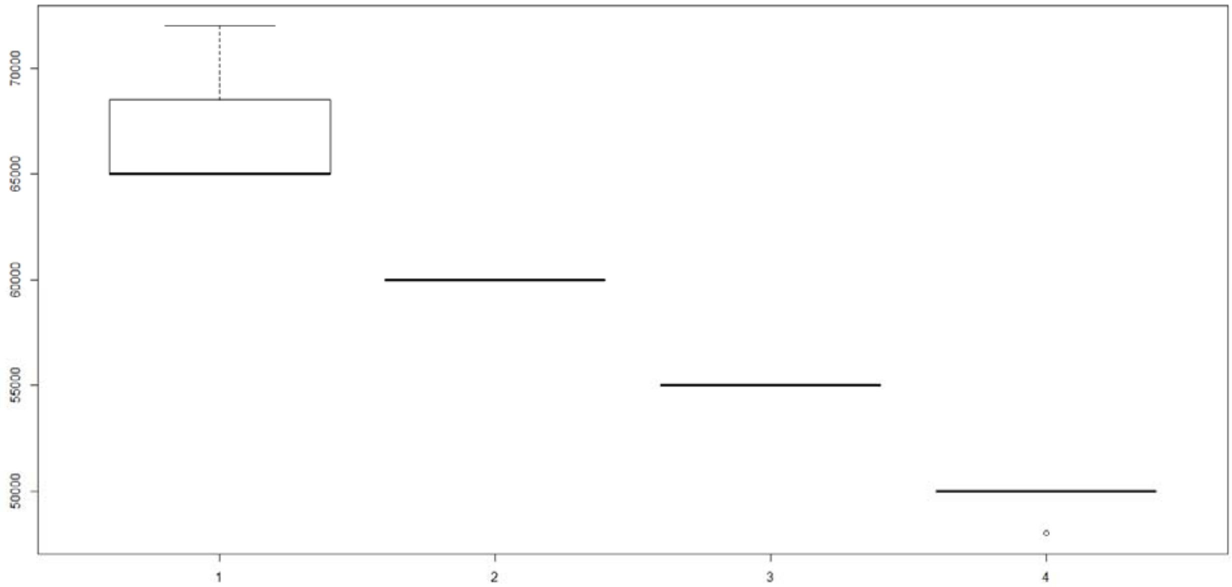

Figure 31. Figure 32. Box Plot for modalities of the variable PlantingDensity.

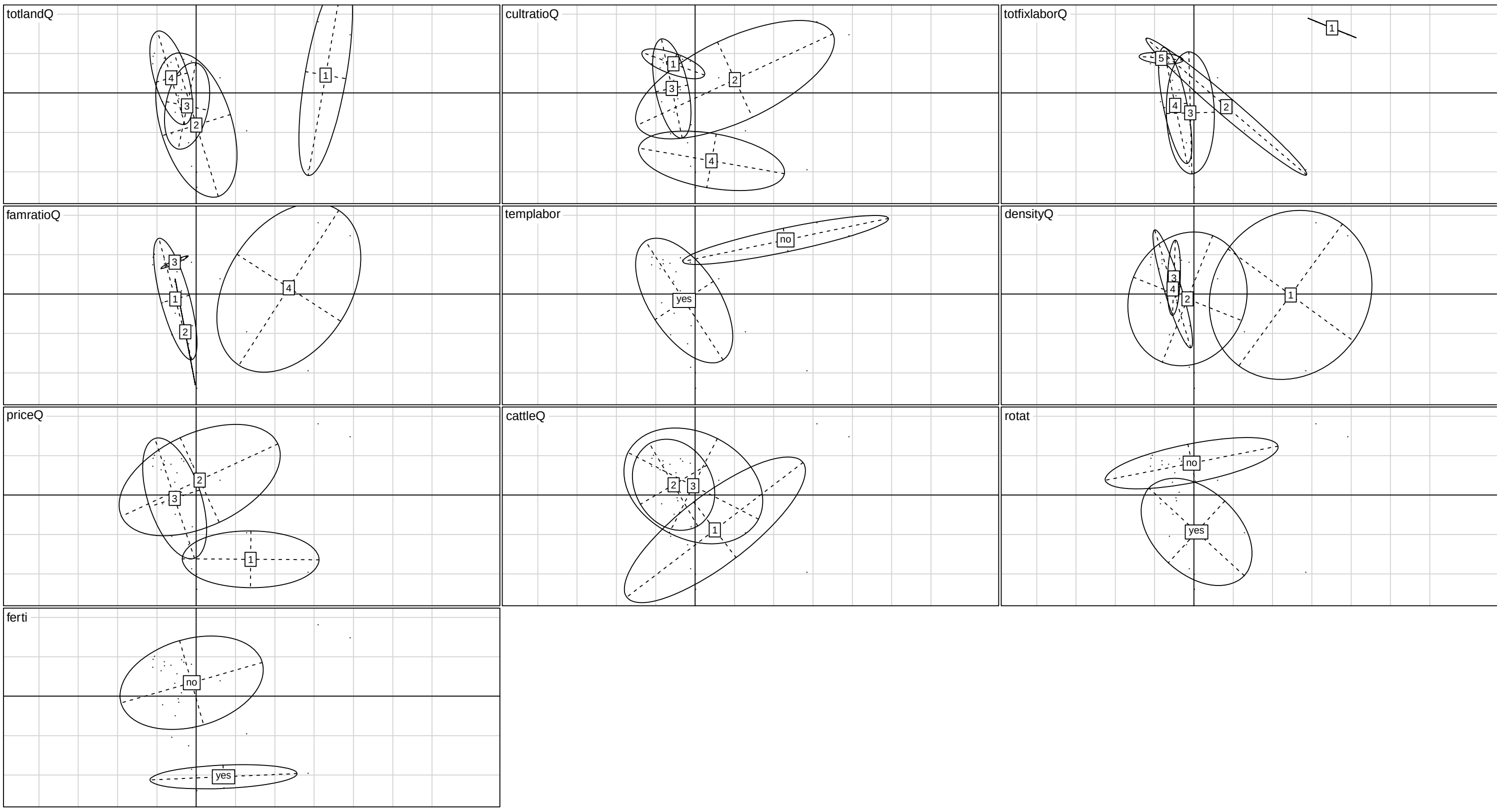

Figure 33. Scatter Plots for key variables .

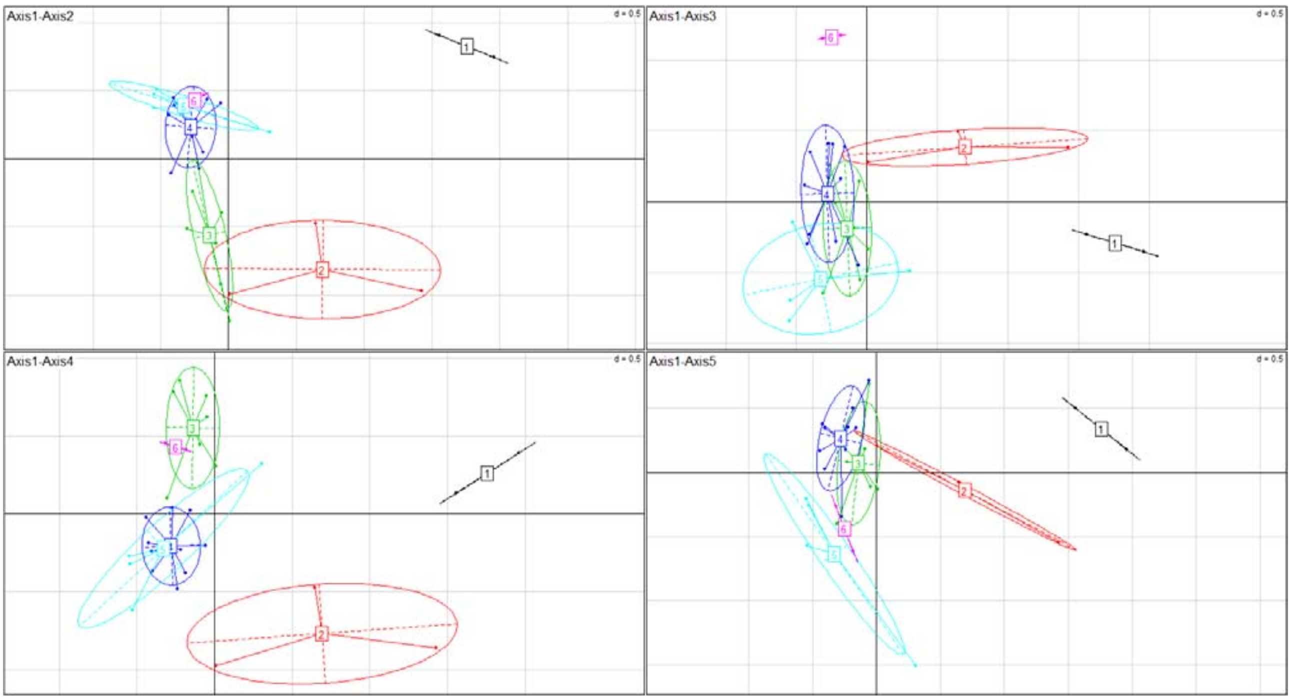

Figure 34. Factorial Maps of 1 -2 Axis, 1-3 Axis, 1-4 Axis and 1-5 Axis.