UNIVERSIDADE DE SÃO PAULO – USP

INSTITUTO DE ENERGIA E AMBIENTE - IEE

PROGRAMA DE PÓS-GRADUAÇÃO EM CIÊNCIA AMBIENTAL – PROCAM

ANDRÉA CASTELO BRANCO BRASILEIRO ASSING

Agroecology: a proposal for livelihood, ecosystem services provision and biodiversity conservation for small dairy farms in Santa Catarina

SÃO PAULO

2018

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Corrected Version

(Original version is in the Institute of Energy and Environment)

Ph.D. Dissertation presented to the Graduate Program on Environmental Science, at the Institute of Energy and Environment, University of São Paulo, to obtain the degree of Doctor in Environmental Science.

Concentration area: Environmental Science

Advisor: Paulo Antônio de Almeida Sinisgalli

SÃO PAULO

2018

PUBLISHER'S CATALOGING-IN-PUBLICATION DATA

Brasileiro, Andréa Castelo Branco.
Agroecology: a proposal for livelihood, ecosystem services provision and biodiversity conservation for small dairy farms in Santa Catarina. / Andréa Castelo Branco Brasileiro; orientador: Paulo Antônio de Almeida Sinisgalli. – São Paulo, 2018.
186f.: il; 30 cm.

Tese (Doutorado em Ciência Ambiental) – Programa de Pós-Graduação em Ciência Ambiental – Instituto de Energia e Ambiente da Universidade de São Paulo.

1. Biodiversidade – conservação. 2. Ecologia agrícola. 3. Leite – Produção. 4. Produtores rurais. I. Título.

Elaborado por Maria Penha da Silva Oliveira CRB-8/6961

ASSING, A. C. B. B. **Agroecology**: a proposal for livelihood, ecosystem services provision and biodiversity conservation for small dairy farms in Santa Catarina. 2018. 186p. Ph.D. Dissertation (Ph.D. in Environmental Science) – Graduate Program on Environmental Science, University of São Paulo, São Paulo, 2018.

Approved in:

Dissertation Examination Committee

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Judgment:____

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Prof. Dr.____

Institution: ____

Judgment:____

Dedicated to Valdecir, Bernardo and Daniel who support and inspire me every day to do my best in contributing for a better society, and my nephews, siblings and parents who made me never doubt I could get here.

ACKNOWLEDGEMENTS

My acknowledgments to the rich contributions received from farmers that allowed us to have many insights and for their voluntary participation in this project. Thanks to Michael Wironen, Barbara Schröter, Juan P. Alvez, Claudia Sattler, Darci Pitton, Alison Adams, Virginia Kades, Bryan O'Connor, and Jennifer Porter for the rich discussions and contributions that help me to develop this dissertation.

Thanks to Abdon Schmidt and Joshua Farley for the coordination of the project which this dissertation is part of. Additionally, I thank Joshua Farley for being my advisor for the Certificate in Ecological Economics, at University of Vermont, during my "Doutorado Sanduiche".

Thanks to Paulo Sinisgalli for accepting, for the second time, to be my advisor. He was more than it during the time I have spent to accomplish my master and PhD degrees. He was a psychologist, friend and, sometimes, the father figure I needed in the hard moments far from my biological family. He inspires me to be a good, but humanized professional. Thank you so much for being part of my academic life, and naturally becoming part of my list of friends.

Thanks to Alessandra Carvalho, Amanda Silva, Ana Lúcia Pacheco, Caroline Cichoski, and Cristina Cuiabália Pimentel for being good friends and allowing me to share with them my thoughts, ideas, fears, anguishes, and also many joys, during this dissertation elaboration process.

I thank the professors Ernesto Mendez, Ana Paula Fracalanza, Evandro Moreto and Ademar Romeiro for kindly accepting to be part of my Examination Committee. In special, I thank Ernesto for having accepted me in his course on Advanced Agroecology, which provided me many insights to the development of this work.

I am very thankful for the fund received from CiVi.net project of the 7th Framework Programme of European comission, Brazilian Science Council (CNPq) and Brazilian Coordinating Agency for Advanced Training of Graduate Personnel (CAPES), which allowed me to conduct the field work and supported my research. I also thank CNPq to accept me in the "Doutorado Sanduiche" through the "Ciências sem fronteiras" and Pesquisador Visitante do Exterior (PVE)" projects. This opportunity provided me many contributions and discussions present in this dissertation, besides the personal gains resulting of this kind of experience.

“The pessimism creates inertia” (WILSON SCHMIDT, personal communication in 2015).

ABSTRACT

ASSING, A. C. B. B. **Agroecology**: a proposal for livelihood, ecosystem services provision and biodiversity conservation for small dairy farms in Santa Catarina. 2018. 186p. Ph.D. Dissertation (Ph.D. in Environmental Science) – Graduate Program on Environmental Science, University of São Paulo, São Paulo, 2018.

The challenge of balancing food production, ecosystem services (ESs) and biodiversity conservation evidences the disruption of the present agri-food system. This demands a social-ecological system transformation. For this, the replacement of conventional agricultural practices to agroecological ones has been suggested, since these practices could provide ESs provision, which agriculture and human life are dependent on, and a permeable matrix, which is indispensable for biodiversity conservation. However, the food production activity also needs to afford small farmers livelihood, otherwise, they will not be interested in taking part of this transition. In view of this, the present dissertation has the objective of analyzing agroecology as a proposal to provide farmers' livelihood, generate ESs and contribute for biodiversity conservation, integrally. In order to reach the objective proposed, we selected the case study of Santa Rosa de Lima (SRL), located in Santa Catarina (SC) state, which is inserted in area of Atlantic Forest (AF), in Southern Brazil. This municipality has many dairy farmers associated with AF. AF is globally recognized as a priority biome for biodiversity conservation, due to its rich biodiversity and current level of degradation. Furthermore, the biome provides diverse ESs. Dairy activity has been extensively referred as a major driver of AF deforestation, on other hand, dairy activity is of relevance for the state economy and farmers livelihood. Due to the referred, it was brought to SC a potential agroecological and sustainable intensification (SI) dairy system, the management intensive grazing (MIG) system. The hypothesis was that the implementation of this system has potential to increase dairy profitability, reduce reliance on off-farm inputs, provide ESs and decrease pressure on remaining forest. Additionally, by increasing stocking rate and milk yields, farmers may be able to retire land from production to conservation without suffering an economic loss. To analyze the results of MIG implementation in SRL, as an agroeological system with potential to balance economic and ecological goals, we compared social, ecological and economic data of farmers applying MIG and farmers applying conventional systems. These data were collected through farmers interview and an accounting project conducted in the city during one year. As first research result, we found that MIG is still in process to become considered an agroecological system. Therefore, we analyzed this process of transformation through the lenses of social theories for social-ecological system transformation. In summary, our results has showed that MIG is more profitable than conventional systems, have increased land efficiency and showed signs of environmental improvements, however, still needs progresses to become an agroecological and sustainable intensification system. This process of transition has already started in SRL, since, among the mentioned and other evidences, MIG has gradually reduced the use of environmentally damaging inputs and farmers has showed to be more prone to meet environmental law. Our results also indicate social learning as indispensable, and financial capital as necessary to foment the process of transformation. To introduce both in the process, Participatory Processes and Payment for Ecosystem Services are advocated as suitable tools.

Kew-words: Ecosystem Services. Biodiversity Conservation. Livelihood. Dairy Production. Small farmers.

RESUMO

ASSING, A. C. B. B. **Agroecologia**: uma proposta para provisão da subsistência de pequenos produtores de leite, serviços ecossistêmicos e conservação da biodiversidade em Santa Catarina. 2018.186p. Tese de doutorado (Doutorado em Ciência Ambiental) – Programa de Pós-Graduação em Ciência Ambiental, Universidade de São Paulo, São Paulo, 2018.

O desafio de equilibrar produção de alimentos, provisão de serviços ecossistêmicos (SEs) e conservação da biodiversidade evidencia a ruptura do sistema agroalimentar em vigor. Esta transição demanda uma transformação do sistema social-ecológico. Para isto, a substituição de práticas convencionais por práticas agroecológicas tem sido proposta, uma vez que estas geram SEs, do qual a agricultura e a vida humana são dependentes, e uma matriz permeável, que é indispensável para conservação da biodiversidade. Entretanto, a atividade de produção de alimentos também deve ser pensada no sentido de garantir a subsistência de pequenos produtores rurais, caso contrário, eles não apresentarão interesse em participar desta transição. Devido a isto, a presente tese tem por objetivo analisar a agroecologia como uma proposta para a subsistência de agricultores, a geração de SEs e contribuição na conservação da biodiversidade, integradamente. Para alcançar o objetivo proposto, foi selecionado um estudo de caso localizado em Santa Rosa de Lima (SRL), no estado de Santa Catarina (SC), em área de Mata Atlântica (MA), na região sul do Brasil. Este município possui vários produtores rurais associados à MA. A MA é globalmente reconhecida como um bioma prioritário para conservação da biodiversidade, devido a sua rica biodiversidade e estágio atual de degradação. Além do mais, o bioma oferece diversos SEs. A atividade de produção de leite tem sido recorrentemente referida como uma das principais causas de desmatamento de MA, por outro lado, esta atividade é de relevância para a economia do estado e subsistência de produtores rurais. Devido ao exposto, foi trazido para SC um sistema de produção de leite com potencial para ser agroecológico e de intensificação sustentável (IS), o sistema de Manejo Intensivo de Pastagem (MIP). A hipótese inicial consistia em que a implementação deste sistema tem o potencial de aumentar a lucratividade da atividade, reduzir a dependência de insumos externos à propriedade, gerar SEs e diminuir a pressão sobre os remanescentes florestais. Adicionalmente, através do aumento da taxa de estocagem e produção de leite, produtores podem estar aptos a separar terra, antes dedicada para a atividade, para conservação, sem sofrer perda econômica. Para analisar os resultados da implementação do MIP em SRL, como um sistema agroecológico com potencial para equilibrar metas econômicas e ecológicas, nós comparamos dados sociais, ecológicos e econômicos entre produtores que adotam MIP e produtores que adotam sistemas convencionais. Estes dados foram coletados através de entrevistas e um projeto contábil realizado na cidade durante um ano. Como primeiro resultado, nós diagnosticamos que o MIP está ainda em processo de tornar-se agroecológico. Entretanto, nós analisamos este processo de transformação através das lentes da teorias sociais. Em síntese, nossos resultados mostraram que o MIP é mais lucrativo, tem aumentado eficiência no uso da terra e tem mostrado sinais de melhoras ambientais, mas ainda necessita progressos para tornar-se um sistema agroecológico e de intensificação sustentável. Este processo de transição já tem se iniciado em SRL, uma vez que, além de outras evidencias e as já mencionadas, MIP tem reduzido gradativamente o uso de insumos danosos ao ambiente, e produtores tem se apresentado mais inclinados a atender a legislação ambiental. Nossos resultados também indicaram aprendizagem social como indispensável, e capital financeiro como necessário ao fomento do processo de transformação. Para a introdução de ambos no processo, Ações Participativas e Pagamentos por Serviços Ecossistêmicos são entendidos como ferramentas adequadas.

Kew-words: Serviços Ecossistêmicos. Conservação da Biodiversidade. Subsistência. Produção de Leite. Pequenos Produtores Rurais.

SUMÁRIO

SUSTAIN ECOSYSTEM SERVICES IN BRAZILIAN SOUTHERN ATLANTIC FOREST.

CHAPTER 1

GENERAL INTRODUCTION

1 GENERAL INTRODUCTION

In 1998, Federal University of Santa Catarina (UFSC) brought to Santa Catarina (SC) State an alternative dairy system to the conventional ones: the Management Intensive Grazing (MIG) system (ALVES, 2012). In MIG, animals graze in paddocks for a short period of time and are then rotated to a new paddock (WINSTEN; PARSONS; HANSON, 2000). This approach is also known as the Voisin Rational Grazing System (VRG), in reference to its proponent André Voisin. This system requires the fulfillment of four laws: Rest, Occupation, Maximum Yield, and Regular Yield (MACHADO, 2010; MELADO, 2003). These laws advocate managing the pasture and herd in a way that respects the recovery time of the grass, avoids overgrazing, and respects the different nutritional requirements of the animals (VOISIN, 1988). In short, MIG controls pasture and grazing intensity in order to improve the pasture-based feed systems (MURPHY, 1994), which includes the management of cattle, pasture and soil (MACHADO, 2010).

UFSC's initiative to promote the implementation of the MIG in SC had many motivators, as follow:

a) **The advanced level of deforestation in Santa Catarina Atlantic Forest (AF).** According to SOS MATA ATLÂNTICA (2017), SC should be entirely covered by AF, however, due to deforestation and land conversion, remnants of forest cover only 23% of the state area. In 1990, the AF remnant covered 25% of its original area. For the whole country, this data is still more alarming. Currently, AF remnant in Brazil cover only 12,4% of its original area. Much of what that is highly fragmented, with only 8.5% of the original area existing as forest fragments of at least 100 hectares. In 1990, the percentage of AF remnant was 14%. Deforestation between 1990 and 2016 totals 1,887,596 hectares.

b) **The importance of Atlantic Forest due to its rich biodiversity and its ecosystem service provision**. The biome is home to more than fifteen thousand plant species and two thousand vertebrate species, of these, eight thousand and 654 are endemic species, respectively (SOS MA, 2017; MYERS et al, 2000). It is considered an international priority ("hotspot") for conservation due to the threats facing the region's biodiversity (MYERS et al, 2000). The biome provides many ecosystems services essential for human life, such as, air purification, climate regulation, soil protection, erosion control, water regulation, water purification, water supply, recreation, source of food and fiber, etc. (SOS MA, 2017).

c) The importance of the dairy activity for SC's economy. Santa Catarina is the fourth largest state for milk production in Brazil (SANTA CATARINA, 2017), accounting for 9.6% of all Brazilian milk production (EPAGRI/CEPA, 2018). Milk production is also important for the state economy: ranking second in gross production value among all state agricultural activities in Santa Catarina (EPAGRI/CEPA, 2014). It represents 80% of the total monetary value of livestock activity (INTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2006) and is present in 45% of all Santa Catarina's farms (INTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2012). Milk production increased 69% between 2007 and 2016 in Santa Catarina (EPAGRI/CEPA, 2018).

d) **The impacts of dairy activity on remnants of AF.** Cattle activity has been one of the main drivers of AF deforestation in Brazil (NEPSTAD et al., 2006; MCALLISTER, 2008; GIBBS et al. 2010; COHN et al. 2011). Bustamante et al. (2012) evaluated that 75% of forest conversion in Brazil may be associated with this land use. The area occupied by permanent pasture represents 23.45% of Brazilian territory (INTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2012), and 18% of SC's territory (INTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2006).

e) **The environment conditions of SC's territory which difficult the Brazilian forest code compliance.** Brazilian Forest Code (Law Nº 12.651/2012) requires that rural properties in the Atlantic Forest biome maintain 20% of their total area in native vegetation as a Legal Reserve (LR)[1]. Additionally, this Law designates certain Areas of Permanent Preservation (APP)[2]. The APP includes riparian areas, areas around springs and lakes, hilltops, steep slopes, and areas of high elevation (BRASIL, 2012). The richness of water resources (abundance of rivers and water sources) of Santa Catarina, and its relief conditions (many mountains, hills, and cliffs) difficult the compliance of the Brazilian forest code, since many of these areas are considered APP, so, its economic use is forbidden.

[1] LR is the area located inside of a property or rural tenure with the function of ensuring the sustainable economic use of natural resources in the rural property, supporting the conservation and rehabilitation of ecological processes and promoting the biodiversity conservation, as well as the habitat and protection of wildlife and native flora (Brazil, 2012).
[2] APP is protected area, covered or not by native vegetation, with the environmental function of preserving the hydric resources, the landscape, the geological stability and the biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations (Brazil, 2012).

Based on that, UFSC's project had the objective of implement a sustainable intensification dairy system in which farmers could use more efficiently their pasture area to reduce deforestation, and, perhaps, convert pasture area in area for forest recovery (LASSRE, 2018). Therefore, goals, understood as conflicting, could be simultaneously met: the farmers livelihood promotion, biodiversity conservation, ecosystem services provision, and food production.

Although, in its original proposal (see Voisin, 1988), MIG system consider the use of agrochemicals, UFSC's project presented MIG system to farmers as an agroecological system to, additionally, encourage the organic milk production in the region through the abandonment of agrochemicals' use. UFSC's beliefs on the potential of MIG to be an agroecological system relies on the argument that, if followed the four mentioned laws, the use of chemical fertilizer, for example, is unnecessary. By agroecology, we refer to "an approach that seeks to integrate ecological science with other academic disciplines and knowledge systems to guide research and actions towards the sustainable transformation of our current agrifood system" (MENDEZ et al. 2017).

Since the beginning of the project, UFSC made many partnerships to expand the project and analyze its results. Partnerships were done, in sequence, with the Institution of Agricultural Research and Rural Extension of Santa Catarina (EPAGRI), University of Vermont – United States of America, CiVi.Net project – European comission, and University of São Paulo – Brazil (USP). As result of UFSC initiative, there are above 900 farms adopting MIG system, in 58 Santa Catarina's municipalities (JEREMIAS, 2012). The adoption of MIG in SC became part of the SC public policy to improve milk production in the state.

The present dissertation is also result of those partnerships, as part of the "project results evaluation", and was designed initially to answer the following research question: Has Management Intensive Grazing (MIG) provided farmers' livelihood and, simultaneously, generated ecosystem services and biodiversity conservation in Santa Catarina?

The affirmative hypothesis were supported by the argument that MIG, if applied with agroecological practices, could increase stocking rate, increase milk yield and reduce production costs. Consequently, it would reduce pressure on remaining forest, needed for biodiversity conservation and ecosystem services provision, and increase farmers' profitability. Additionally, applying agroecological practices, the system could generate ecosystem services in it, and turn the pasture matrix permeable for animal interpatch migration, condition strongly needed for biodiversity conservation (CUNHA; GUEDES, 2013).

To answer the research question and test the hypothesis, we selected a study case of Santa Rosa de Lima (SRL), the Agroecological Capital of Santa Catarina, located in the South of the State. Before become a reference on agroecological production in the state, SRL had as main economic activities pig production associated to timber harvest, and tobacco farming that was predominantly replaced by milk production, or organic vegetables crop, in many cases associated to agritourism (MORENO-PEÑARANDA; KALLIS, 2010). To reduce milk production impact on environment and increase its production, MIG was then introduced in five dairy farms as pilot projects, which rapidly spreads among the farms.

We conducted interviews and an accounting project to evaluate economic, social and environmental aspects of the MIG implementation in SRL. Results and discussion were presented separately in three papers.

The discussion to answer the initial research question is present in the papers 1 and 2 (chapter 2 and 3). During the investigation process, we found an important aspect of the MIG system, applied in SRL: the use of agrochemicals integrated with some agroecological practices. This could be associated to a dairy system conversion still in process. That brings us to a second and third research question: Is the dairy systems of SRL in process of transformation to an agroecological one? Could Payments for Ecosystem Services (PES) and Participatory Processes (PPs) support in some way this process?

The hypothesis that PES could support social-ecological transformation of the SRL's dairy system was based in the fact that financial capital is needed for the development and application of alternative techniques to the ones of the system in disruption (MOORE et al. 2014). The hypothesis that PAs could support this process is based in the idea that PAs can promote social-learning, which is an element needed for the construction of new values and beliefs for a new paradigm (MOORE et al. 2014; PAHL-WOSTL, 2009).

The complexity of the topic demand us a holist view in which was needed the use of different science fields. For the paper 1, we predominantly used the knowledge from economics and accountancy. Paper 2, we drank from the sources of conservation biology, landscape ecology and agronomic sciences. In the paper 3, we used theories from the sociology and agroecology[3].

We chose to write the dissertation in format of sequential articles due to our final intention to publish the results of this research in scientific journals. Additionally, we believed it was the most suitable way to address the different research questions, and to use the different disciplines. Therefore, the present dissertation is divided in 5 main sections: this general introduction, followed by the papers 1, 2 e 3 and the general conclusions. Each paper presenting its own introduction, theoretical background, results, discussion of the results and conclusions. In the attachments, we have the questionnaires used for the interviews (**attachments A and B**), the spreadsheets used for the accounting project (**attachments C, D and E**), and the farmers' term of consent of participation and information use.

The discussions presented here can, besides provide an evaluation of the current reaches of Management Intensive Grazing System in Santa Rosa de Lima, help police-makers to better design public policies that aim balance economic, ecological and food production goals.

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CHAPTER 2

AGROECOLOGY AND FARMER LIVELIHOODS: A COMPARATIVE ANALYSIS BETWEEN MANAGEMENT INTENSIVE GRAZING AND CONVENTIONAL DAIRY IN SANTA CATARINA, BRAZIL

2 AGROECOLOGY AND FARMER LIVELIHOODS: A COMPARATIVE ANALYSIS BETWEEN MANAGEMENT INTENSIVE GRAZING AND CONVENTIONAL DAIRY IN SANTA CATARINA, BRAZIL[4]

Abstract

The conflict between food production and environmental conservation demands alternative agriculture practices that can maintain or increase food production, protect and restore critical ecosystem processes, and reduce dependence on non-renewable agricultural inputs. Deforestation in Brazil's Atlantic Forest, for which agriculture has been a primary driver, already threatens the biome's impressive biodiversity and the ecosystem services it helps sustain. Many small family farmers in Santa Catarina - located in the South of Brazil - have adopted the Management Intensive Grazing (MIG) system as an alternative to conventional and environmentally detrimental dairy activities. Whether or not MIG is a viable approach to sustainable intensification on small farms depends on its economic and ecological impacts. This article presents the results of a research project designed to test those impacts. Using detailed interviews and monthly accounting of revenues and expenditures on MIG and conventional farms, we compare the profitability and key social and environmental aspects of both systems. We found that the Management Intensive Grazing system is more profitable than the conventional dairy system in Santa Rosa de Lima, however, the ecological benefits expected with the MIG adoption have been minimized, which can be due to the fact that the potential of system has not been entirely explored. We found a combination of MIG practices with conventional practices, a condition that makes the system not agroecological in all. However, the MIG in Santa Rosa de Lima's case seems to be in the path of the transition to an agroecological system, since it has gradually reduced the use of environmentally degrading inputs.

Key words: Profitability, Management Intensive Grazing, Agroecology, Dairy production.

2.1 INTRODUCTION

The industrialized agrifood system poses a major threat to environmental conservation efforts (TILMAN, 1999) due to its negative impacts on the environment, such as land conversion and habitat loss, wasteful water consumption, soil erosion and degradation, pollution, genetic erosion, and climate change (WORLD WIDE FUND FOR NATURE, 2015). According to Tomczak, (2006) our current food production system has increased crop yields by using large amounts of fossil fuel energy in the form of synthetic nitrogen fertilizers, petroleum based agrochemicals, diesel powered machinery, refrigeration, irrigation and an oil dependent distribution system. The

[4] This paper will be published with the contributions of Abdon Schmitt Filho, Virginia Kades, Bryan O'Connor, Jennifer Porter, Joshua Farley, Paulo Antônio de Almeida Sinisgalli.

dependence on non-renewable fossil fuel resources has become increasingly scarce and expensive. Additionally, it destroys biodiversity, contributes to global climate change, degrades soil and water quality, and also is a threat to food security and future food supply.

According to the Food and Agriculture Organization of the United Nations (FAO), agriculture activities occupies 38.47% of the Earth's surface (FAOSTAT, 2012). The emissions from this activity, jointly with the land use change, is responsible for one quarter of the global anthropogenic greenhouse gas emissions (GHG) in the world (INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, 2014). With 32% of its land in agriculture production, Brazil is the third highest emitter of CO_2 equivalent (CO_2e)[5] emissions from agriculture in the world (FAOSTAT, 2012).

The picture is still worse for cattle activity, which is responsible for the majority of agricultural GHG emissions. Globally, cattle activity is responsible for 47.1% of all agricultural CO_2e emissions due to enteric fermentation and manure left on pasture, and permanent pasture area covers about 21.66% of the land surface (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2012). In Brazil, cattle activity is responsible for 85.9% of all emissions from Brazilian agriculture activities (FAOSTAT, 2012), and the area occupied by permanent pasture represents 23.45% of Brazilian territory (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2012).

If we continue to rely on conventional technologies, agricultural impacts on the environment are likely to worsen as the demand for food increases. The world population has more than doubled in the last 50 years[6] (WORLD BANK, 2015). However, the annual rate of population change has decreased since 1992, the world population is currently increasing by 80,5 million people per year in the last 50 years, and is expected to stabilize at 11 billion by 2100 (UNITED NATIONS, 2015). At the same time, rising incomes are increasing the demand for animal protein, which consequently requires an increase in food production (OECD/FAO, 2015). Furthermore,

[5] Carbon dioxide equivalence is a simple way to normalize all greenhouse gases (such as methane, perfluorocarbons, and nitrous oxide) and other climate influences in standard units based on the radiative forcing of a unit of carbon dioxide over a specified timeframe (generally set at 100 years). For example, one ton of methane would be equal to 25 tons of CO2-eq, because it has a global warming potential 25 times that of CO2 (Yele Climate Connections, 2009).
[6] In 1965, the World population was estimated to be 3.3 billion. In 2015, the world population increased to 7.3 billion (United Nations, 2015).

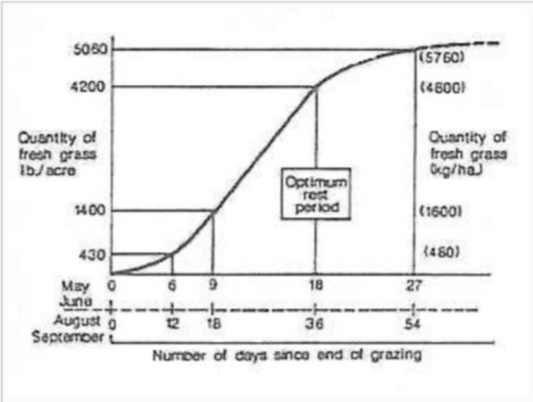
worsening environmental impacts threaten to degrade the ecosystem services upon which agriculture depends. Studies have shown that events caused by global warming, such as flooding, drought, variations in temperature, humidity, wind and precipitation can compromise yields of some crops and grain quality (KUNDZEWICZ; GERMANY, 2012). FAO estimates that climate change alone may reduce agricultural output during the period from 2080 up to 2100 by 30% in Africa, and up to 21% in the developing countries as a whole (FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS, 2009). Our generation is thus charged with addressing the ongoing conflict between feeding the world and conserving nature.

Sustainable intensification has been presented as an alternative that combines food production with environmental conservation, since it seeks to "increase food production from existing farmland in ways that place far less pressure on the environment and that do not undermine our capacity to continue producing food in the future" (GARNETT; APPLEBY ; BALMFORD, et al., 2013, p. 33). In addition to that, agroecology has been presented as an alternative that enhances ecosystem services in agroecosystems. Agroecology, as a set of practices, seeks sustainable farming systems that increase yields, reduce year to year variation, require fewer external inputs and generate lower negative environmental or social costs through the application of techniques that respect ecological relationships and processes (SILICI, 2014).

For cattle activity, one alternative that embraces both sustainable intensification and agroecological practices is Management Intensive Grazing (MIG). In MIG, animals graze in paddocks for a short period of time and are then rotated to a new paddock (WINSTEN; PARSONS; HANSON, 2000). This approach is also known as the Voisin Grazing System (VGS), in honor to its proponent André Voisin. This system requires the fulfillment of four laws as defined by André Voisin: Rest, Occupation, Maximum Yield, and Regular Yield (MACHADO, 2010; MELADO, 2003). These laws advocate managing the pasture and herd in a way that respects the recovery time of the grass, avoids overgrazing, and respects the different nutritional requirements of the animals (VOISIN, 1988). In short, MIG (or VGS) controls pasture and grazing intensity in order to improve the pasture-based feed systems (MURPHY, 1994), which includes the management of cattle, pasture and soil (MACHADO, 2010).

The optimal grass rest period is calculated based on the curve of grass re-growth as explained by Voisin (1988). The curve has a sigmoid shape (**figure 2.1**), as well as the curve of grass growth, in which there is an early period of slow growth, followed by a central period of rapid growth and a final period of slow growth. The optimum rest period will be located in the central period, and will be defined by number of days that the pasture reached the largest quantity of grass per hectare that has grown since the end of grazing.

Figure 2.1 − Curve of re-growth in grass



Source: Voisin (1988).

2.1.1 Dairy production in Brazil and Santa Catarina

According to the Brazilian Institute for Agricultural Research (EMBRAPA), there are three main dairy-farm feeding systems practiced in Brazil: extensive, semi-intensive and intensive. The extensive dairy farming is a solely pasture-based feeding system, semi-intensive dairy farming incorporates pasture as the base feed source, though some protein and energetic supplements are utilized, and intensive dairy management is considered to be a confinement system in which the animal is fed entirely through protein and energy supplements (BRAGA, 2010; CAMPOS, 2015).

Consensus on definitions of dairy systems are not easily found in the literature, and this is still more difficult for pasture-based feeding systems, as forage availability depends upon climate and soil, which varies by region (ALVEZ, et al., 2014, DARTT, et al., 1999, GILLIESPIE, et al., 2009, HANSON, et al., 2013, PARKER; MULLER; BUCKMASTER, 1990). Therefore, for simplification, the concept adopted by EMBRAPA will be adopted here in this study. However, since their definition is primarily based on the animals' diet, and to avoid misunderstandings between composition of diet and applied technique, we will refer to the terms pasture-based, semi pasture-based and non pasture-based for extensive, semi-intensive and intensive, respectively. The most common practice in Brazil for dairy activity has been the pasture-based system, representing 58.61% of all farms, followed by semi pasture-based system, which represents 40.42% of all farms (BRAGA, 2010).

MIG is included in the pasture-based feeding systems explained above (GILLESPIE et al., 2009). During the late 1990s, MIG gained popularity on family dairy farms in Santa Catarina, a state located in Southern Brazil, through a project developed by the Federal University of Santa Catarina (UFSC) and The State Agricultural Research and Extension Agency (EPAGRI) (ALVEZ et al.; 2015). Although there is no data specifically on the percentage of MIG farmers in Santa Catarina that adopt MIG, 69.87% of the farms utilize the pasture-based feeding system and 29.51% use the semi pasture-based system (BRAGA, 2010). It follows that there is a high potential for MIG implementation.

The MIG system offers an attractive alternative to the conventional, semi and pasture-based feeding systems that do not manage the pasture by dividing the pasture area in paddocks. Some of the economic outcomes reported for MIG, when compared with other systems, include lower operating costs, reduction of labor requirements, reduction of animal health problems, reduction of expenses attributed to crop production, and risks related to the reliance on out-farm inputs, resulting in higher net returns per unit of milk produced or per cow (PARKER; MULLER; BUCKMASTER, 1992; HANSON et al., 2013; TAUER & MISHRA, 2006; GILLESPIE, et al., 2009; WINSTEN; PARSONS; HANSON, 2000). Reported environmental benefits include the recovery of natural pasture, water retention, decrease in erosion, increases in biodiversity, improvement of fertility and porosity of the soil, natural control of pests, carbon sequestration, water regulation, and nutrient cycling (VOISIN, 1988; MELADO, 2007; MEURER, 2008; MURPHY, 1996; BAUER, 2009; HANSON et al., 2013; BOLLAND, et al., 2011; DERAMUS, et al. , 2003; GOULDING; JARVIS; WHITMORE, et al. 2008; FARLEY, et al., 2012). In short, MIG offers a sustainable alternative to conventional cattle production that can improve family farmer livelihoods while reducing or even reversing ecological degradation (Farley, et al. 2012). This is particularly apropos for the family dairy farms researched in the present study.

The state of Santa Catarina is located in the Brazilian Atlantic Forest Biome, which is both one of the most biologically rich and most threatened ecosystems in the planet, making it an international hotspot for conservation priorities (MYERS, et al., 2000; JOLY, et al., 2014; ALVEZ, 2015; FARLEY, et al. 2012). Additionally, family farmers have been the largest providers of milk for domestic consumption in Brazil; 60% of all milk consumed in the country is from family farm production (EPAGRI/CEPA, 2014). Brazil is the sixth largest milk producer in the world (FOOD AND AGRICULTURE ORGANIZATION, 2013), and Santa Catarina is the fourth largest state for milk production in the country, accounting for 9.8% of all Brazilian milk production (SANTA CATARINA, 2017). Milk production is also important for the state economy: ranking second in gross production value among all state agricultural activities in Santa Catarina (EPAGRI/CEPA, 2014). It represents 80% of the total monetary value of livestock activity (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2013) and is present in 45% of all Santa Catarina's farms (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2012).

Even with all of the advantages and benefits mentioned due to application of the MIG system, it is still not used by all farmers in the region. According to Parker; Muller and Buckmaster (1992), the uncertainty of economic and production outcomes from implementing a new system, for example a system like MIG, could be one of the factors that make farmers avoid to adopt it. Despite the purported benefits of the MIG system, specific economic data on the use of MIG for dairy farmers in the state of Santa Catarina (SC) were not found [7]. Therefore, faced with the importance of providing information about the MIG system's performance to dairy farmers, this paper will analyze economic indicators, as well as some related social and environmental indicators of conventional and MIG systems, as they have been applied in the small-farmer dairying region of Santa Rosa de Lima- SC. In fact, 45% of dairy farmers are applying MIG (PMSRL, 2015)[8], and it will be tested the profitability of these systems in this region. We hypothesize that farms utilizing MIG will have higher stocking rates, higher milk production per hectare, higher cow productivity, and lower input costs, resulting in improved farmer livelihoods and more profitability.

[7] We found researches that calculates the costs of implementation of the system (Brugnara, 2015; Dias, 2014; MACHADO, 2004; MOURA, 2007), but nothing showing the annual production costs in farms already applying the system.

[8] Information provided by the Santa Rosa de Lima City Hall in July, 2015.

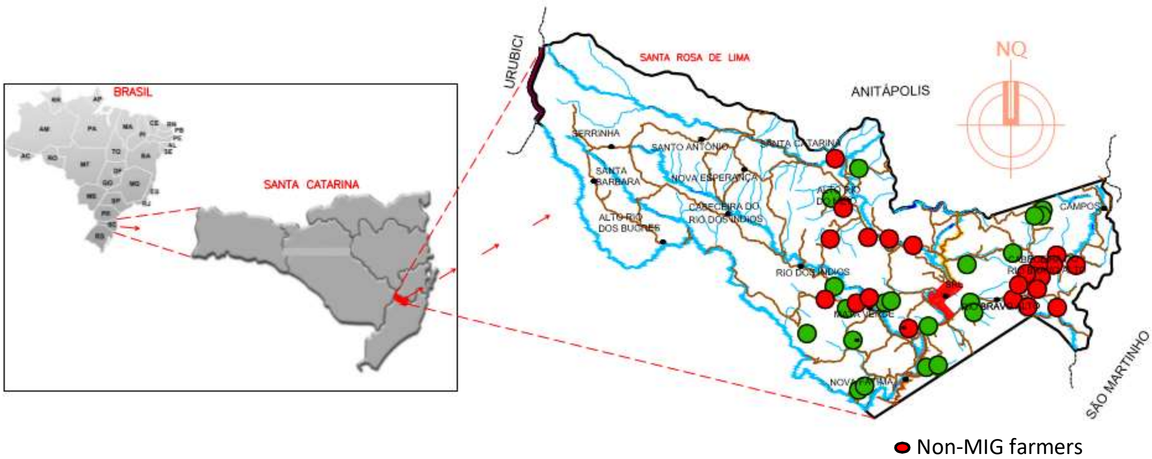
2.2 METHODS

2.2.1 Study case and sample

Santa Rosa de Lima (SRL) is a small municipality located in the south of Santa Catarina, a Brazilian state located in the southern region of the country. Three quarters of SRL's 2,065 inhabitants live in rural areas (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2010). A large part of its population works in agroecological activities, giving the city the title of the Agroecological Capital of Santa Catarina (PMSRL, 2014). The results presented here is part of a larger research project that has been developed by the Federal University of Santa Catarina (UFSC) to encourage dairy farmers to use agroecological practices in the state[9].

As it will be detailed later, these farms were randomly selected and are distributed in the municipality as **figure 2.2** shows.

Figure 2.2 − Farmers' Sample Location



Source: Assing (2016)[10]

[9] The support to farmers to implement Voisin Rational Grazing System in Santa Catarina has been accomplished by the students of the Silvopastoral Systems Laboratory of UFSC, under the coordination of the professors Abdon Luiz Schmitt Filho and Alfredo Celso Fantini. This actual research is part of the CNPq project titled "Synergies between ecosystems services and agroecology in the Atlantic Forest", under the coordination of professor Ademir Antônio Cazella, and it has professor Joshua Farley as invited visiting researcher.

[10] Figure developed by Valdecir Assing exclusively to this paper.

The red spots in **figure 2.2** are non-MIG farms and the green spots are MIG-farms. The sample represents 34% of all dairy farms in the municipality, and 38% and 30% of the MIG and non-MIG farms, respectively[11]. All farmers that had their pasture divided into paddocks and rotated their animals daily were considered to be operating MIG farms. Non-MIG farmers are all those that applied other systems.

2.2.2 Data Collection

Data for this study was collected in two separate phases. The first phase lasted 40 days, taking place between April 1st and May 10th of 2013. Personal interviews were conducted with 40 family farms in Santa Rosa de Lima, Santa Catarina, Brazil. The fact that SRL is considered the Agroecological Capital of Santa Catarina State was the main reason to select this municipality to participate in the research. We expected that this fact could be a factor of influence in the appliance of agroecological practices in the dairy activity and could allow us to find farmers applying the authentic MIG Rational System, that is, farmers following the agroecological recommended principles by MIG (1988). We randomly selected 20 farms utilizing traditional pasture management (pasture and semi pasture-based without MIG techniques) and 20 utilizing MIG that were closely located, in order to facilitate the monthly visitation logistics of the second phase of data collection. The farmers' willingness to be a volunteer in the project was also one of the sample selection determinants. The questionnaire for the interview was developed based on Meurer (2008), Francisco (2012), Alvez (2014), Jeremias, (2012), and Longo (2013). The questionnaire consisted of 176 questions regarding the characteristics of the farm and family, management and zootechnical characteristics, technical assistance, characterizations and management of the MIG system project, organic production, milk production, pasture conditions, animal behavior, animal feed, herd health, economic indicators, ecosystem services, willingness to take part in payments for ecosystem service programs, and environmental law. The objective of these interviews was to document the

[11] According to Santa Rosa de Lima City Hall, the total dairy farms in the municipality is 119. From them, 53 are applying Voisin Grazing System and 66 are applying conventional system. Our sample (40 farms) seems relatively small for statistical analysis; however, it is not small if it is considered the total number of dairy farms in the city. Additionally, due to limited resources of people and funding for this kind of detailed and extensive work, it was not possible to survey more than 40 farmers.

family farmers' perceptions on issues related to their activity and property related to economic, social, environmental, and legal aspects. In this paper, we only used a subset of the questions, which are presented in the tables 1, 2 and 3 (Result section).

The second phase of data collection consisted of detailed annual accounting data. Differently from the first interview, the second data collection's objective was not to document the farmers' perception, but to collect factual information on production, costs, income and sales of the dairy activity. Farmers were asked to account for dairy related expenditures and revenues during one year, between August 2013 and July 2014. From 40 farmers (our initial sample), 35 agreed to participate. However, during the project some of them withdrew (3 farmers), and during the data analysis some had to be excluded from the sample due to incomplete information (4 farmers), or because the income from sale of animals was higher than the income from sale of milk (1 farmer). Therefore, resulting in a final sample size consisted of 27 farms, 15 using MIG and 12 conventional methods.

Accounting data was collected through monthly visits to each participating farm. Taking advantage of farm visits, we implemented an associated extension project to help family farms learn how to monitor their financial activity and assess farm profitability, which we called "Dairy Production Accounting Project of Santa Rosa de Lima". In addition to these monthly meetings, we organized one workshop in which farmers were informed about the background of the project and taught how to record the necessary data. Tauer and Mishra (2006) state that accounting systems affect profits, since farmers who record and monitor their activities are better able to identify and reduce cost inefficiencies. Furthermore, participation in extension activities and the use of extension agents are positively associated with dairy farm financial performance (ibid). So, the objective of this extension work was to collect data accurately and instruct family farms with regards to the accounting system.[12]

[12] In November of 2015, each farmer received the accounting report of their dairy activity, and the general performance of dairy activity in the municipality was presented to them in a workshop.

2.2.3 Accounting Method

Since our objective was to analyze just the economic activity of dairy farming, only data regarding milk and cattle production were recorded, rather than the economic activities of the entire farm.

The spreadsheets were developed based on the International Accounting Standards Board (IASB) rules, which are the primary method of Brazilian accounting (CPC, 2013). For the income statement analysis, information on costs and revenues were recorded. Specifically, for production cost calculation, we applied cost definitions based on the cost accounting approach. We applied the absorption costing method, which considers the average full cost (variable and fixed) to produce a good as the unit production cost (Garrison, et al., 2011). Farmers completed a spreadsheet with information on their variable, fixed, and opportunity costs. Variable costs are those spending that vary with production, and fixed costs are spending that are not affected by the amount produced, at least in short term (Balakrishnan, et al., 2012; Martins, 2015). The fixed costs are items that have to be paid in the short term even if production drops to zero. The interpretation of the costs as variable or fixed depends on individual aspects of each economic activity. For example, electricity that is consumed according to production volume in a mechanized industry, can be classified as fixed cost in a craft production business, in which electricity is not a direct production input, but in some way is consumed to provide the environmental conditions for human work, such as an illuminated work space. The correct classification of the costs in variables and fixed are very important when we want to estimate costs for future production projections, or determine product price, because the total fixed costs divided by production unit will decrease with production increase[13], while the total variable cost divided by production unit will keep the same. Since our objective is calculating the total cost production for cost comparison analysis between two systems, we will not be over emphasizing this issue in presenting the costs classification for dairy activity. Among the items listed as part of the production cost, cost of sales and other expenses we have: animal feed (crop and supplements), veterinary costs, insemination, electricity, fertilizer, herbicide, grass seedlings and seeds, crop seedlings and seeds for silage, maintenance of machines and

[13] This is true at least in short term.However, if the production increase is very large, probably the total fixed cost will vary to another level, due to the abrupt transition of production volume.

building, taxes (annual tax on rural property and car annual registration), insurance (life and car insurance), machine rental, fuel, and labor.

The opportunity costs are those that are not actually incurred, but represent forgone income (idem). Since farmers wanted to know how much they in fact spent on milk production, and they do not recognize their work as a cost, we decided to classify family labor as an opportunity cost. Other example of opportunity cost identified was the on-farm use of raw materials harvested, for example using wood for fences in lieu of timber sales. Additionally, it was considered as opportunity costs the amount that farmers could receive for leaving money in a saving account rather than spending in production process, that is the saving account interest rate (0.0616 registered for the accounting year) [14]multiplied by production cost[15].

To attribute monetary value to family labor we recorded how many people in the family dedicated time to animal management and how many hours a day it took. We therefore multiplied the total family hours dedicated to this occupation by the expected payment per rural labor hour in Santa Rosa de Lima municipality (R$ 8.75/hour)[16] to get the monthly family labor cost of dairy activity. Additional tasks for dairy activity, such as pasture improvement, insemination, machinery and building repairs, and silage and crop production were also calculated in hours and multiplied by the rural average payment for the region.

On family labor, it was realized during data analysis that MIG and Non-MIG famers stated similar time dedicated to animal management, which includes feeding the animal in the barn, milking cows, and conduce animals to pasture area and barn. The daily average time of family labor for both systems were very similar 7.62 hours/day and 6.71 hours/day for MIG and Non-MIG farms, respectively. Once labor is classified more commonly as a variable cost[17], data on family labor time for animal management seems unrealistic. Since MIG farmers showed more animals and cows

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[14] Information obtained from the “citizen calculator” available on the Central Brazilian Bank website (www3.bcb.gov.br).

[15] Our objective was to calculate the opportunity cost of the production investment, not the opportunity cost of the total investment (assets). To compare the options of investment in the dairy activity and saving money, we calculated the Return on Assets.

[16] Farmers stated that the average payment for rural work in the municipality was around R$ 70.00, that is R$ 8.75/hour.

[17] It is not common labor cost to be classified as a fixed cost, since it is, majority, a direct cost in the production, but in some cases labor is classified as fixed if there is not direct relation between production volume and hour of labor utilized in the production process (Martins, 2015). Perhaps, labor for the dairy activity in Santa Rosa de Lima is a fixed cost, but it cannot be stated with conviction before a more detailed data collection is done. For future research it is recommended to do a daily record of the time that farmers spend for animal management.

than Non-MIG farmers, as will be shown in the results section, this difference should be higher and significant. One explanation for this could be the difficulty in an interview to state how many hours of work were dedicated to an activity, if a daily record of labor time is not done. Anyway, we decide maintain this information since it is in important production cost item[18] and reflects the farmer's perception on their labor time dedicated for animal management.

For the income statement analysis, the sales from dairy activity were recorded. The milk sales were considered the main product and animal sales were considered the sub-product of the dairy activity. Farmers that had more than 50% of their income due to animal sales were excluded from the sample.

For the balance sheet analysis, the assets and liabilities were recorded and compared to understand the financial solvency of the activity. Only assets[19] used in the dairy activity were considered. These included land (for pasture and crops of animal feed), machines (milking machines, milk coolers, forage crushers, weed whackers, and chainsaws), tools (shovels and wheelbarrows), buildings (barns, manure compost dumps, and warehouses), transports (cars or motorcycles), and herd (cows, heifer, calves, and bulls). Some of the machines and transports were also used for activities other than dairy production on the farm, however these represented a small percentage of the farm income and were thus ignored. Another reason to consider the total value of these machines in our analysis is the understanding that they are as assets subject to liquidation in case of debt payments. This methodological decision is therefore justified by our objective in presenting the solvency capacity of dairy activity[20]. We used the value of liquidation stated by the farmer for asset value. We ignored depreciation for three reasons: 1) the liquidation price already assumes depreciation; 2) 80% of asset values were from assets with negligible depreciation or even rising values due to market dynamics (for example land and biological assets); and 3) information about

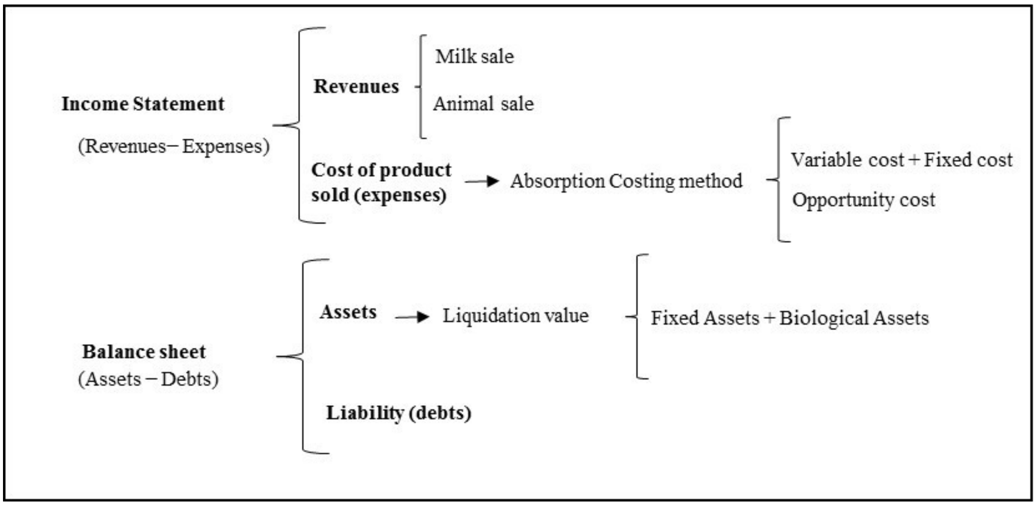
[18] Unpaid labor was the main component of the total production cost, representing 46% and 56% of the Voisin and Non-Voisin Cost II totals. The total unpaid labor represents 91% and 94% of the farmers' opportunity cost.

[19] On the assets sheet, money that farmers had in a checking or savings account were not recorded, since it was our first year with the project and the trust were still being constructed. It was also assumed that farmers would likely not feel comfortable sharing this very personal information.

[20] Once some machines are used in other activities than dairy activity, the ideal procedure would be to account for the amount of time that each machine is used in each farm activity individually, and then calculate the percentage concerning just for dairy activity. Additional to the reasons presented in the methodology to consider the total value of these machines in our analysis, it was not possible to define the percentage of use that was dedicated only for dairy activity, because the information about how many hours is demanded in the use of these machines was not recorded.

purchase price and time of use was not available. **Figure 2.3** below summarizes the framework used for the accounting analysis for dairy activity.

Figure 2.3 − Accounting Analysis framework for Dairy Activity



Source: Own elaboration.

2.2.4 Economic Analysis

In order to do the economic analysis, some conventional indicators were calculated, such as Net Income, Return on Assets (ROA) and the Benefit Cost Ratio (BCR).

The Net Income is the result of the gross profit minus production costs and other expenses, such as depreciation, interest, and taxes. The gross profit is a company's total revenue minus the cost of goods sold (production costs and costs associated with selling the product). Both measures are conventionally presented in the income statement (Averkamp, 2016a). The opportunity costs are not usually recorded in the income statement, but they are costs that should be considered in making decisions (Averkamp, 2016b). In the same manner, the payments of debts are not included in the income statement, they are presented in the balance sheet. The interests paid due to these loans and debts are included in the income statement to calculate the net income, as part of other expenses. The conventional procedure is to segregate the interests due to debts and the parcel of debts that is actually due to the investment, and include them in the income statement (as other expenses) and balance sheet, respectively. However, in our analysis it was not possible to separate them, since some farmers did not know the interest rate they were paying.

The income statement reported to farmers were developed based on farmers' requirements[21]. They wanted to know how much they in fact were paying for production, receiving for product sales, not receiving due to opportunity cost, and how much they additionally had to generate in income in order to cover their debts due to their investment in assets. Therefore, we presented them three measures of net income, and consequently three measures of cost. The hypothetical income statement below shows how we reported to farmers their income statement.

Hypothetical Income Statement

Revenue……………………………………………………………100.00
Cost of goods sold ……………………………………….....50.00
Other Expenses…………………………………………...10.00
Cost I……………………………………………………..60.00
Net Income I ………………………………………………………………40.00
Opportunity cost…………………………………………...5.00
Cost II……………………………………………………...65.00
Net Income II…………………………………………………………...35.00
Debts of the accounting year…………………………………10.00
Cost III…………………………………………………..75.00
Net Income III………………………………………………………………..25.00

Therefore,

Cost I = Cost of goods sold + other expenses (1)

Cost II = Cost I + opportunity cost (2)

Cost III = Cost II + debts (3)

And,

Net Income I = Revenue – Cost I (4)

[21] The measures of farmers' interest were collected during the collection of data by the researcher. It was done, since farmers were the main target audience to have access to the results of this research.

$$\text{Net Income II} = \text{Revenue} - \text{Cost II} \tag{5}$$

$$\text{Net Income III} = \text{Revenue} - \text{Cost III}. \tag{6}$$

With Cost I, farmers can determine the primary annual costs due to the dairy production and sales (production and sales cost + other expenses). For Cost II, farmers can determine the minimum results they need to reach in order to cover any production costs and their salary, as well as to make their activities economically viable for savings investments, i.e. opportunity costs. Cost III shows whether the farmers are able to pay all the production costs (fixed, variable and opportunity), other expenses and the debts that they owe due to dairy activity. This last information shows farmers how much they need to generate in income to avoid the liquidation of assets or new loans. For the reasons mentioned before, we could not segregate from the debts the parcel related to interests and the parcel related to the loan acquired for the investment in assets. Thus, when we refer to debts, interest is also included.

Still on measures of profitability, we calculated the Return on Assets and the Benefit Cost Ratio, as mentioned before. The ROA is a measure of profitability that is calculated as the difference between the income and costs divided by assets as shown in **equation 7**. The BCR was calculated as the ratio between the income and the production costs as shown in **equation 8**.

$$\text{ROA} = (\text{Revenue} - \text{Cost}) / \text{Assets} \tag{7}$$

$$\text{BCR} = \text{Revenue} / \text{Cost} \tag{8}$$

Both indicators measure how efficient management is at using its assets and investment to generate earnings, and were calculated conserving the three measures of cost, resulting in ROA I, II and III; and BCR I, II and III.

2.2.3 Statistical Analyses

We normalize all variables related to costs, profit and income by liter, hectare and animal unit (AU)[22], in order to evaluate these variables through the economic, ecological and animal efficiency lenses, respectively.

To analyze the differences between farm characteristics of the two groups (MIG and Non-MIG farmers), we used t-tests for data that were normally distributed and the Mann–Whitney U test for data that were identified as nonparametric. To test the normality of distributions, we applied the Kolmogorov-Smirnov test. Analyses were conducted using IBM Statistical Package for Social Sciences (SPSS) Version 24.

To evaluate the real significance of the T test and U test results, effect size tests were conducted for the variables that showed significance equal or higher than 0.10 ($p \geq 0.10$). “Estimates of effect size are useful for determining the practical or theoretical importance of an effect, the relative contribution of different factors or the same factor in different circumstances, and the power of an analysis” (FRITZ; MORRIS; RICHLER, 2012).

The effect size tests used were the Cohen’s *d* effect size. For data identified as parametric we used the online effect size calculator of the University of Colorado[23]. “The larger an effect size is, the bigger the impact the experimental variable is having and the more important the discovery of its contribution is” (FRITZ; MORRIS; RICHLER, p. 14, 2012). The effect size $d \leq 0.2$ is considered as a small effect; if $0.2 < d \leq 0.8$, the effect is considered medium; and if it is > 8, the effect size is considered to be large (FRITZ; MORRIS; RICHLER, 2012; LINDENAU; GUIMARÃES, 2012).

For non-parametric data, the Cohen’s effect size was calculated by the division of the standard score, z, (obtained from the U test) by the square root of the total sample size (N), as suggested by Fritz, Morris and Richler (2012). See **equation 9**:

$$r = \frac{z}{\sqrt{N}} \quad (9)$$

[22] To calculate animal unit, we used the equivalences based on the Embrapa’s suggestion (https://sistemasdeproducao.cnptia.embrapa.br/FontesHTML/Leite/GadoLeiteiroZonaBragantina/index.htm). Therefore, we assumed that: 1 adult bull or ox = 1.25 UA; 1 cow = 1 UA; 1 heifer =0.75 UA; and a calf or younger heifer =0.25 UA.

[23] https://www.uccs.edu/~lbecker/

The large, medium and small effect size for non-parametric data is defined by: $r \leq 3$ = small, $3 < r \geq 5$ = medium, and $r > 5$ = large[24].

To better understand the effect size *d* results, we utilized the probability of superiority (PS) correspondent to the effect size result according to Fritz, Morris and Richler (2012) table on the associated *d, r* and PS values. According to the authors, "PS gives the percentage of occasions when a randomly sampled member of the distribution with the higher mean will have a higher score than a randomly sampled member of the other distribution" (p. 14, 2012). For example, The PS for a *d* of 0.8 is 71%. Therefore, if you sampled items randomly, one from each distribution, the one from the condition with the higher mean would be bigger than that from the other condition for 71% of the pairs.

2.3 RESULTS

The results are presented in sequence: the environment, social and economic aspects of the dairy activity. The environmental and social aspects are results of the analysis of the data collected in the first interview, based on farmers' perception. The environmental aspects, besides soil biodiversity, animal health, soil quality and use of chemicals, include pasture conditions. The economic aspects present the analysis' results of the data collected in the accounting project. It includes general farm system characteristics, income statement and balance sheet results.

2.3.1 Based on farmer's perception

Environmental aspects

As previously mentioned in the introduction section, the Management Intensive Grazing (MIG) System has some advantages benefiting the environment when compared with other dairy systems. Some of these benefits accrue to farmers, while others take the form of positive externalities, i.e.

[24] Fritz, et al. (2012) suggested that *d* effect size values of 0.8, 0.5, and 0.2 represent large, medium, and small effect sizes, respectively; and for *r* effect size values, a large effect is 0.5, a medium effect is 0.3, and a small effect is 0.1. To better define the size of *d* and *r,* we decided establish a scale for them as presented in the methodology.

benefits to society but not to the farmer directly. In the case of Santa Rosa de Lima, it was possible to identify some of these advantages based on farmers' perceptions, such as soil quality (porosity and moisture) and animal health, which benefit primarily the farmer. MIG farms showed better performance for soil porosity and moisture. 75% and 85%, respectively, of all MIG farmers stated that these indicators of soil quality had improved in the last 10 years, against 15% and 20% of Non-MIG farmers. The significance of this result was confirmed by the large effect size and PS (see **table 2.1**).

Table 2.1 − Environmental aspects

Variables	*MIG (n=15)*	*Non-MIG (n =12)*	*p-value*	*Effect Size*	
	Percentage	**Percentage**		***R***	***PS (%)***
Use of chemical fertilizer on pasture area	80%	35%	0.004*	0.45	76
Use of herbicides	50%	25%	0.107		
Soil porosity	75%	15%	<0.0001*	0.67	90
Soil moisture	85%	20%	<0.0001*	0.70	91
Soil biodiversity	55%	35%	0.064*	0.29	66
Animal health	95%	40%	<0.0001*	0.66	89

** denotes significance at α = 0.10*
Source: Own elaboration.

The percentage of farmers using herbicides and fertilizer was found to be higher for MIG farmers, but the difference was statistically significant just for fertilizer use. The significance of the difference on the use of fertilizer was confirmed by the medium close to large effect size and probability of superiority (0.45 and 76, respectively). However, the perception on the increase of soil's biodiversity on pasture area in the last 10 years was more predominant among MIG farmers (55% compared to 35% for non-MIG farmers), as evidenced in **table 2.1**, which presented a small close to medium effect size and a PS of 66.

The MIG system allows for pasture improvement more easily than in other pasture-based farming systems, since it uses fences to divide pasture area into paddocks in a way that enables the farmer to decide and implement the best time for animal grazing. In Santa Rosa de Lima's case, the practice of planting new grasses and leguminous plants has been common among the MIG farmers. This practice allows the pasture to survive frost and gives the animals a more diversified diet. One hundred percent of the MIG farmers do pasture improvements,[25] and 95% practice overseeding[26]

[25] Pasture improvements includes, besides overseeding, other techniques of planting grasses and leguminous.
[26] Overseeding is referred here as the technique of sowing one type of grass onto another already existing grass.

in pasture areas; among non-MIG farmers, these percentages were 65% and 10%, respectively (see **table 2.2**). The significance of the differences for overseeding and improvement of pasture was confirmed by the large and medium close to large effect sizes, respectively.

Table 2.2 − Pasture condition

Variables	*MIG (n=15)*	*Non-MIG (n =12)*	*p-value*	*Effect Size*		
	Percentage/average	**Percentage/average**		***r***	***d***	**PS (%)**
Winter overseeding	95%	10%	<0.0001*	0.84		98
Improvement of pasture	100%	65%	0.004*	0.45		76
Variety of grass	3.58	2.3	0.008*		0.94	75
Variety of leguminous plants	1.76	1.3	0.026*		0.72	69

* denotes significance at α = 0.10
Source: Own elaboration.

In the overall sample, we identified 15 varieties of grasses and four leguminous plants. The largest variety was found in MIG farms, which had all 15 types of grass and four leguminous plants, compared to nine types of grasses and three types of leguminous plants in the non-MIG farms. On average, MIG farms have 55% more varieties of grass and 35% more varieties of leguminous plants than non-MIG farms (see **table 2.2**). The variety of grass and leguminous plants presented large effect sizes and PSs, confirming therefore the significance of the differences between MIG and non-MIG System. Tilman and Downing (1994) showed that primary productivity in more diverse plant communities is more resistant to, and recovers more fully from, a major drought. Based on that, MIG farmers seem to have more capacity to deal with extreme climate events due to global warming.

Social aspects

As mentioned, some authors (ALVEZ, 2012; ALVEZ et al., 2014; FARLEY et al., 2012; SODER; ROTZ, 2001) stated that the MIG system requires less family labor than other systems; less time is spent, for example, on fertilization and cleaning the barn. For our sample, however, only 10% of the MIG farmers stated that their workload had decreased with the adoption of the system. The reduction of workload was not as it was expected, denying one of our initial hypothesis and opposing the results found by Alvez (2012), which stated that farmers' workload fell from 8 to 4 hours per day in 66% of farms after MIG adoption. In our research interview with MIG and Non-

MIG Farmers, we avoided to induce the answer by asking them if the workload in the dairy activity had decreased in the last 10 years (average time of MIG adoption in the municipality), instead of asking them if the workload had decreased after MIG adoption, as was done by Alvez (2012). However, the fact that the MIG farmers' workload did not reduce in part was expected, since by fencing the pasture area, MIG farmers realized the opportunity to improve pasture by planting new grasses and leguminous, which is not easily done if the area is not isolated from animals. No difference was found between the two systems with regards to the number of family members that receive other sources of income (see **table 2.3**).

Table 2.3 − Social Aspects

	MIG (n=15)	*Non-MIG (n =12)*	*p-value*	*Effect Size*	
	Percentage/Average	**Percentage/average**		***r***	***PS (%)***
Decrease of workload	10%	50%	0.074*	0.28	65
Income from other source	0.95	1.4	0.151		

* denotes significance at α = 0.10
Source: Own elaboration.

2.3.2 Based on Accounting Project Information

General Farm System Characteristics

The animal diets in the dairy systems found in Santa Rosa de Lima are comprised mainly of pasture, corn silage, forage and rations[27], which classifies MIG and non-MIG farmers alike as using semi pasture-based systems. All farmers leave the animals in the pasture all day and then feed them in the barn twice a day while they are being milked.

Table 2.4 − Concentrate and Silage

Variable	*MIG (n=15)*		*Non-MIG (n =12)*		*p-value*	*Effect Size*	
	Mean	**SD**	**Mean**	**SD**		***d***	***PS (%)***
Rations (Kg/cow and heifer/day)	1.65	1.24	1.05	0.96	0.181		
Silage (Kg/cow and heifer/day)	6.49	3.72	8.84	2.27	0.067*	0.76	70

** denotes significance at α = 0.10*

Although MIG farmers feed cows and heifers 1.65 kg of rations (purchased feed) per day, which is 57% more than the non-MIG farmers (1.05 kg/day), this difference showed low significance. In

[27] Wheat bran, Corn bran, Soybean bran, and mix of assorted cereals.

contrast, the non-MIG farmers feed cows and heifers with 36% more silage than do MIG farmers. This difference had a considerable significance (p-value equal to 0.06). The effect size *d* calculated for these distributions was considered to be medium, close to large (0.76), which means that there is a medium to large significance in the difference found between the groups due to the type of system adopted. The probability of superiority (PS) shows that the percentage of probability that a non-MIG farmer is feeding animals with silage more than MIG farmers is 70% for each pair that we randomly take, one from each group (see **table 2.4**).

Farm characteristic (**table 2.5**) shows the total area of the farm dedicated to dairy activity (pasture and crop area for silage), number of animals (cow, steer, bull, calf, and heifer), number of cows (lactating and dry cows), animal unit, and the stocking rate. The stocking rate is presented for total dairy area and pasture area, using number of animals and animal unit as numerator of the equation (number of animals/total area and animal unit/total area, for example).

Table 2.5 − Farm Characteristics

Variable	*MIG (n=15)*		*Non-MIG (n =12)*		*p-value*	*Effect Size*	
	Mean	**SD**	**Mean**	**SD**		***d***	***PS (%)***
Dairy farm area (Ha)	15.85	5.88	12.29	3.92	0.084*	0.71	69
Pasture area (Ha)	11.45	5.82	8.75	2.67	0.126		
Cropped land (Ha)	4.4	3.2	3.54	1.74	0.411		
Number of animals (cows, heifer, steer, calf, and bull)	48.47	14.89	32.75	14.35	0.010*	1.07	78
Total Animal Unit (AU)	35.9	12.11	25.22	13.44	0.040*	0.83	72
Number of cows	23.33	9.58	12.92	5.99	0.003*	1.30	82
Stocking rate of pasture area I (animal/ha)	4.92	2.16	3.54	1.74	0.196		
Stocking rate of pasture area II (AU/ha)	3.63	1.77	3.14	2.02	0.508		
Stocking rate of dairy farm area I (animal/ha)	3.36	1.54	2.87	1.37	0.392		
Stocking rate of dairy farm area II (AU/ha)	2.49	1.32	2.27	1.49	0.692		

**denotes significance at α = 0.10.Note. All units are in Reais, the Brazilian currency. Exchange rate: R$2.24 to US$1.00.*[28]

Source: Own elaboration.

As for the farms' size, when the pasture area and crop area are analyzed individually, the differences do not show statistical significance, but when they are summed together as the overall dairy farm size, the difference shows a significance of 0.084, an effect size of 0.71 and a PS of 69.

[28] The exchange rate registered in the end of data collection period, according to the Brazilian Central Bank: http://www4.bcb.gov.br/pec/taxas/port/ptaxnpesq.asp?id=txcotacao.

Therefore, the average MIG farm size was higher than the average non-MIG farm size. As for herd characteristics, herd size, total animal unit (AU) and the number of cows between the two systems showed significant statistical differences; all of them were higher for MIG farms. The significance of these differences were confirmed by the large effect size and PS found for these three variables. The stocking rates of the pasture area were not significantly different independently, if the area is normalized by number of animals or AU. When the crop area for silage is added to show the stocking rate for the overall farm area, the difference is still more insignificant (see **table 2.5**).

Income Statement and Balance Sheet Results

As it was mentioned in the methodology, all variables related to the cost, income and profit were normalized by hectare, liter, and AU, in order to analyze these variables according to these ecological, economic and animal efficiency aspects.

Table 2.6 − Farm Inputs

Variable	*MIG (n=15)*		*Non-MIG (n=12)*		*p-value*	*Effect Size*	
	Mean	**SD**	**Mean**	**SD**		*d*	*PS (%)*
Cost I (R$/month/Hectare)	201.44	159.98	124.26	68.52	0.132		
Cost I (R$/month/Liter)	0.47	0.09	0.55	0.17	0.181		
Cost I (R$/month/AU)	77.04	35.36	59.74	23.95	0.160		
Cost II (R$/month/Hectare)	379.23	214.94	305.37	119.15	0.297		
Cost II (R$/month/Liter)	1.04	0.48	1.46	0.49	0.037*	0.85	73
Cost II (R$/month/AU)	153.34	43.54	158.36	63.09	0.809		
Cost III (R$/month/Hectare)	418.24	232.45	319.21	121.18	0.194		
Cost III (R$/month/Liter)	1.15	0.53	1.57	0.69	0.089*	0.67	68
Cost III (R$/month/AU)	168.96	46.04	169.28	82.08	0.990		
Unpaid labor (R$/month/Hectare)	162.01	66.91	169.01	60.66	0.781		
Unpaid labor (R$/month/Liter)	0.54	0.43	0.86	0.38	0.053*	0.79	70
Unpaid labor (R$/month/ AU)	70.01	27.45	93.00	45.78	0.144		
Paid labor (R$/month/Hectare)	0.76	0.79	0.70	1.24	0.880		
Paid labor (R$/month/Liter)	0.003	0.004	0.0028	0.005	0.952		
Paid labor (R$/month/AU)	0.35	0.40	0.22	0.31	0.358		
Rations (R$/month/Hectare)	111.05	131.86	48.59	35.90	0.125		
Rations (R$/month/Liter)	0.22	0.09	0.20	0.11	0.590		
Rations (R$/month/AU)	39.12	26.38	22.17	14.35	0.057*	0.79	70
Fertilizer (R$/month/Hectare)	15.90	8.67	21.56	21.50	0.406		
Fertilizer (R$/month/Liter)	0.04	0.02	0.08	0.05	0.039*	0.92	74
Fertilizer (R$/month/AU)	7.02	4.12	8.18	5.74	0.355		
Herbicides(R$/month/Hectare)	2.98	2.10	1.58	1.37	0.058*	0.78	70
Herbicides(R$/month/Liter)	0.008	0.004	0.008	0.007	0.934		
Herbicides(R$/month/AU)	1.18	0.47	0.95	1.05	0.495		
Total feed (R$/month/ Hectare)	180.09	148.11	113.39	65.65	0.161		
Total feed (R$/month/Liter)	0.41	0.10	0.50	0.20	0.190		

It continues

Continuation

Variables	MIG (N=15)		Non-MIG (N=12)		*P-Value*	Effect Size	
	Mean	**SD**	**Mean**	**SD**		***d***	***PS***
Total feed (R$/month/AU)	68.66	33.42	54.27	24.95	0.227		
Medication costs (R$/month/Hectare)	8.78	11.95	3.50	1.99	0.113		
Medication costs (R$/month/Liter)	0.018	0.015	0.017	0.009	0.893		
Medication costs (R$/month/AU)	3.45	4.98	1.95	1.41	0.323		
Opportunity costs (R$/month/Hectare)	176.89	72.14	180.07	66.34	0.907		
Opportunity costs (R$/month/Liter)	0.57	0.43	0.91	0.39	0.046*	0.81	71
Opportunity costs (R$/month/AU)	75.91	26.93	98.37	47.12	0.160		

**denotes significance at α = 0.10*
Note. All units are in Reais, the Brazilian currency. Exchange rate: R$2.24 to US$1.00.
Source: Own elaboration.

The Cost I, II and III calculations have not presented statically significant differences between MIG and non-MIG systems, except for the Cost II and III when normalized by liter, which were 40% and 36% higher for non-MIG farmers, respectively. These differences were confirmed by the large and medium effect size and PS (*d* = 0.85 and PS=73 for the cost II/month/liter; and *d* =0.67 and PS =68 for the cost III/month/liter), see **table 2.6**.

The largest component of Cost I was purchased feed (rations), representing 47% and 34% of the MIG and non-MIG farmers' Cost I totals, respectively. MIG farmers spent more money on rations than the non-MIG farmers. However, this difference was significant just for the cost with rations normalized by animal unit, which was 76% higher for MIG farmers. The effect size was very close to a large classification (*d* =0.79) and the PS equaled 70 confirms the significance of this difference.

Although 90% of the MIG farmers have stated in the first interview that after the adoption of the MIG system their total workload had either not changed or had increased, the value of family (unpaid) labor, when normalized per liter, was significantly smaller for MIG farmers, and the significance of this difference was confirmed by its effect size and PS, 0.79 and 70, respectively. This is expected, since the milk production is higher for MIG farmers due to the combination of higher number of cows (**table 2.5**) and similar productivity (**table 2.7**)[29]. This has also been reflected in the difference found in the opportunity cost normalized by liter (60% higher for non-

[29] The average monthly milk production of Voisin farmers was 6,152.88 liters, while the average for non-Voisin farmers was 2,707.90 liters. Therefore, Voisin farmers' milk production was 127% higher than non-Voisin farmers milk production.

MIG farmers), since the unpaid labor was the main component of the opportunity cost for both systems (46% and 56% of the MIG and non-MIG Cost II totals), and again the MIG farmers have more milk production. For the opportunity cost normalized by liter, the significance of the difference was also confirmed by the large *d* and PS (0.81 and 71, respectively).

Regarding the use of fertilizer, in the first questionnaire applied to all 40 farmers, just 35% of the non-MIG farmers stated that they used chemical fertilizer in the pasture area, which is much less than the percentage of MIG farmers that also confirmed the use of the chemical fertilizers in their pasture (80%).

In the accounting project, in which we recorded the use of chemicals during one year, it was verified that when the area of crop for silage is considered, all farmers are using chemical fertilizers with the exception of one MIG farmer that has also a pig farm, and thus uses the manure from it to fertilize the soil instead of chemicals. The results of the average costs including fertilizer, normalized by hectare and animal unit, were not statistically different for the two systems. However, when normalized by liter, it was found that non-MIG farmers are spending 100% more on fertilizer than MIG farmers. The large *d* and PS found confirm the significance of this difference (0.92 and 74, respectively).

Based on the first interview with farmers, with a *p value* of 0.087, it was found that the difference in the percentage of MIG (50%) and non-MIG (25%) farmers that use herbicide was higher for MIG farmers, however it was not statistically significant. Based on the data from the accounting project, the difference in spending on herbicides, normalized by hectare, showed that MIG farmers spent 88% more on herbicides per hectare than non-MIG farmers. It is confirmed by the *d* (0.78) and PS (70) found. Additionally, the percentage of farmers using chemical herbicides was different when compared with the first interview. 100% of the MIG farmers used herbicides and just one of the non-MIG farmers did not use it during the period of accounting project. The difference between these percentages could be due to: a) different periods of data collection (the first one was in April of 2013, and the second during August 2013 through July 2014); b) in the first interview we asked just about the use of chemicals on pasture area, while in the accounting project we asked about the use of chemicals in the total dairy area, which includes crop area; and c) the fear farmers might have of getting a bad reputation if they admitted in the interview that they use chemical fertilizers.

In the accounting project, the declaration of this information was in part hidden, because they were not being asked for the use of chemicals outright, but rather the costs involved in producing milk.

Based on the farmers' perceptions, animals on MIG farms have displayed better health conditions than on non-MIG farms (**table 2.1**), however, based on the accounting project, it was observed that there was no difference in spending on medications between the two types of systems independently of the denominator used for the normalization of data (hectare, liter, or animal unit), see **table 2.6**.

Farm outputs include cow productivity, the average of milk produced per hectare, revenue normalized by hectare, liter and AU, the participation of revenue from milk sales and animal sales in the total sales and the coefficient of milk production variation. Cow productivity is the average of daily milk production. In order to obtain this result, the total daily milk production was divided by the number of lactating cows[30] (**table 2.7**).

Table 2.7 − Farm Outputs

Variable	*MIG (n=15)*		*Non-MIG (n=12)*		*p-value*	*Effect Size*	
	Mean	**SD**	**Mean**	**SD**		*d*	*PS (%)*
Cow productivity (liter/cow/day)	12.38	4.43	10.06	2.80	0.128		
Land productivity (milk liter/month/Hectare)	426.78	303.20	237.24	172.31	0.066*	0.76	70
Revenue (R$/month/Hectare)	444.75	296.36	277.40	174.56	0.096*	0.68	68
Revenue (R$/month/Liter)	1.07	0.10	1.21	0.34	0.178		
Revenue (R$/month/AU)	174.83	69.64	135.56	58.53	0.131		
Milk sales (% of total sales)	0.94	0.08	0.86	0.18	0.149		
Animal sales (% of total sales)	0.06	0.08	0.14	0.18	0.149		
Coefficient of milk production variation	0.196	0.079	0.243	0.084	0.146		

**denotes significance at α = 0.10*
Note. All units are in Reais, the Brazilian currency. Exchange rate: R$2.24 to US$1.00.
Source: Own elaboration.

The average productivity per cow unit (milk production/ day/ lactating cow) was higher for MIG farmers, however, this difference between the two systems had low statistical significance. However, the difference of milk production per hectare was 80% higher for MIG farmers, which means that they are producing more milk per unit of hectare, with more farm area. This difference

[30] It was observed that the number of lactating cows was on average 70% of the total cows. Therefore, cow productivity was obtained by total daily milk production/(0.70*number of cows).

showed to be significant, which was confirmed by its medium to large effect size and PS (0.76 and 70, respectively).

The revenue did not show a difference between the two systems when normalized by liter and animal unit, but when normalized by hectare, this difference was significant. However, this significance was not considered very high, it showed a *p*-value of 0.096, a medium effect size (*d*=0.68), and consequently, a probability of superiority not too high (PS = 68), see **table 2.7**.

The coefficient of milk production variation[31] was 24% higher for non-MIG farmers than for MIG farmers. This was expected, since the MIG farmers showed more practices of pasture improvement, one of the influential factors in the animal feed and consequently in milk production. However, this difference was not statistically significant (see **table 2.7**).

Table 2.8 − Farm Balance Sheet

Variable	*MIG (n=15)*		*Non-MIG (n=12)*		*p-value*	*Effect Size*	
	Mean	**SD**	**Mean**	**SD**		***D***	***PS (%)***
Assets (R$)	436075.81	128654.93	345655.00	124735.33	0.078*	0.71	69
Debts (RS)	55747.73	46268.56	9852.08	15482.8	0.002*	1.33	82
Balance (assets – debts) (R$)	380328.08	134779.03	335802.92	126157.53	0.389		

**denotes significance at α = 0.10*
Note. All units are in Reais, the Brazilian currency. Exchange rate: R$2.24 to US$1.00.
Source: Own elaboration.

The assets are shown to be 26% higher for the MIG farmers than for non-MIG farmers, but MIG farmers have debts 466% higher than the non-MIG farmers, confirmed by a medium and large effect size, respectively. The balance between the assets and debts shows that both systems have good solvency, or in other words, similar capacity to comply with their liabilities using their assets (see **table 2.8**).

Recapitulating what was mentioned in the methodology section, the Net Income, Return on Assets and Benefit Cost Ratio were used as measures of profitability. These measures were calculated for the three categories of costs: Cost I (costs of production, sales and other expenses), Cost II (Cost I plus opportunity costs), and Cost III (Cost I plus opportunity costs and debts), resulting in

[31] The coefficient of milk production variation is the fraction of the standard deviation of milk production divided by its average. It shows the relative average variation of the milk production.

calculations for Net Income I, II and III; ROA I, II and III; and BCR I, II and III. Additionally, Net Income was normalized by hectare, liter and animal unit (AU).

Table 2.9 − Profitability Measures

Variable	*MIG (n=15)*		*Non-MIG (n=12)*		*p-value*	*Effect Size*	
	Mean	**SD**	**Mean**	**SD**		***d***	***PS (%)***
Net Income I (R$/month/Hectare)	243.31	143.39	153.13	122.17	0.096*	0.67	68
Net Income I (R$/month/Liter)	0.60	0.14	0.66	0.35	0.537		
Net Income I (R$/month/AU)	97.79	40.54	75.81	52.55	0.231		
Net Income II(R$/month/Hectare)	65.52	128.91	-27.97	129.83	0.074*	0.72	69
Net Income II (R$/month/Liter)	0.02	0.48	-0.24	0.56	0.193		
Net Income II (R$/month/AU)	21.49	57.42	-22.80	65.27	0.073*	0.72	69
Net Income III(R$/month/Hectare)	26.51	124.11	-41.81	141.92	0.194		
Net Income III (R$/month/Liter)	-0.08	0.52	-0.35	0.76	0.292		
Net Income III (R$/month/AU)	5.86	58.24	-33.72	87.58	0.172		
ROA I	0.10	0.07	0.06	0.04	0.081*	0.72	69
ROA II	0.03	0.05	-0.01	0.05	0.026*	0.91	74
ROA III	0.01	0.05	-0.02	0.06	0.068*	0.73	69
BCR I	2.38	0.67	2.40	0.90	0.946		
BCR II	1.17	0.38	0.94	0.41	0.143		
BCR III	1.06	0.35	0.91	0.43	0.356		

**denotes significance at α = 0.10*
Note. All units are in Reais, the Brazilian currency. Exchange rate: R$2.24 to US$1.00.
Source: Own elaboration.

Although there were differences found in the average of all Net Income between the two systems, these differences were only significant for Net Income I/hectare and Net Income II normalized by hectare and animal unit. For these calculations MIG farmers presented a higher Net Income than non-MIG farmers. The calculated effect size determined that the significance of this difference is classified as medium (see **table 2.9**).

The Return on Assets (I, II and III), which represents the return in profit for each monetary unit of investment on assets, were higher for MIG farmers, and these differences were confirmed by their medium and large effect size. However, these returns were not attractive enough in either system to be competitive with the Brazilian compensation interest rates on savings accounts for the period (0.0616/year), except for the ROA I for MIG farmers, which was 0.10

The Benefit Cost Ratio, which shows how much income a monetary unit invested in production generates, proved to be more attractive than the compensation interest rate on savings for both systems for using the calculations incorporating Costs I. For the calculation using Cost II and III, the BCR was more attractive than the compensation interest rate on savings just for MIG farmers[32]. Comparing the two systems, the BCR was not significantly different for any method of calculation (see **table 2.9**).

2.4 DISCUSSION OF THE RESULTS

The MIG system, in the case study of Santa Rosa de Lima, showed better performance when compared with other pasture-based systems applied in the municipality for some variables. In terms of animal health, MIG farms have shown better performance based on farmers' perceptions, however it is not clear if their better performance was due to the MIG system helping to interrupt cattle parasite's reproductive cycles, or if it was due to the use of medications and health problem prevention, since similar costs of medicines were found for both systems.

The MIG farmers have more land dedicated for dairy activity, along with more cows, number of animals and animal unit, which could be translated into more wealth. However, in terms of efficiency, MIG farmers did not show statistically significant higher stocking rates (number of animals and animal unit/hectare) or productivity (milk/cow/day) than the non-MIG farmers. Analogous analysis can be made for the assets. MIG farmers are shown to have more assets, however their debts also were higher, and in this way they have similar solvency capacity to the non-MIG farmers. Though, related to the amount of milk produced per hectare, MIG showed high efficiency producing 80% more milk/hectare than non-MIG farmers.

Surprisingly, according to the accounting data, 93% of the MIG farmers are using chemical fertilizer. According to the defenders of the MIG system, due to the management of the pasture through the application of four laws of MIG, the use of fertilizer should become unnecessary. The decision of farmers to use fertilizer can be hypothesized in a number of ways: a) the farmers' fear to decrease their grass production if they do not use chemical fertilizer; b) there is no recognition of the marginal reduction in soil production over the long-term by using these chemical inputs; and/or c) farmers are anxious for the fastest results with regards to grass growth.

[32] To be more attractive than the compensation interest rate on savings, BCR I has to be more than 1.0616, and BCR II and III have to be more than 1, since these two indicators already include 6% of the savings accounting as opportunity costs in their calculations.

Although defenders of MIG System claim that no fertilizer is necessary, and the use of this chemical can increase production costs, André Voisin does not totally eliminate the vantages of fertilizer use (VOISIN, 1988)[33]. In his book "Grass Productivity: An Introduction to Rational Grazing", he mentions the beneficial influence of fertilizer on the vigor of growth and on the production of grass. Quoting the results of previous research, Voisin states that the grass production increases 70% due to chemical fertilizer application (Nitrogen, Phosphorus and Potassium). It is possible, though, to conclude that Management Intensive Grazing System possibly reduces the demand of chemical fertilizer, but does not totally eliminate the needed of its use, which can partially justify the use of this chemical by MIG farmers in Santa Rosa de Lima.

The farmer's decision to use herbicide is more related to concerns about its environmental impact than on factors that differentiate MIG from other dairy systems, since weed management practices are not mentioned in MIG system protocol. MIG farmers have spent more on herbicides per hectare than non-MIG farmers. A reason for this could be due to the belief in regional culture that the presence of weeds in pasture area represents "farmer's laziness." MIG farmers showed more intensive pasture management than the non-MIG farmers, evidenced by the techniques of pasture improvement that they applied, such as fertilization of pasture area and insertion of grass and leguminous plant varieties. In order to not been considered a lazy farmer they also controlled weeds. A question that arises, however, is that if farmers could manage weeds using agroecological principles, why use chemicals instead? The hypothesized answers are: a) lack of knowledge of agroecological practices for weed management, b) no recognition of the negative effects of the use of these chemical inputs on the environment and animal and human health, and c) farmers are anxious for quick results.

Despite of the use of chemicals, the data based on farmers' perceptions showed that MIG farmers perceive more soil biodiversity than Non-MIG farmers. This result is very antagonistic since, with the use of chemical herbicide and fertilizer in the pasture, less biodiversity is expected to be found. Perhaps the fact that MIG farmers manage the pasture more than non-MIG farmers allows them to perceive the soil's biodiversity changes more than the non-MIG farmers, or the use of chemicals were not high enough to compromise soil's biodiversity and the ecological gains of the MIG system. If MIG improves soil quality, it probably improves land value as well. If MIG is

[33] Although Voisin considers the use of fertilizer, he brings attention to the fears about the penetration of the fertilizer into the pasture.

ecologically better, then simply remaining economically competitive with conventional pasture would be a winning situation.

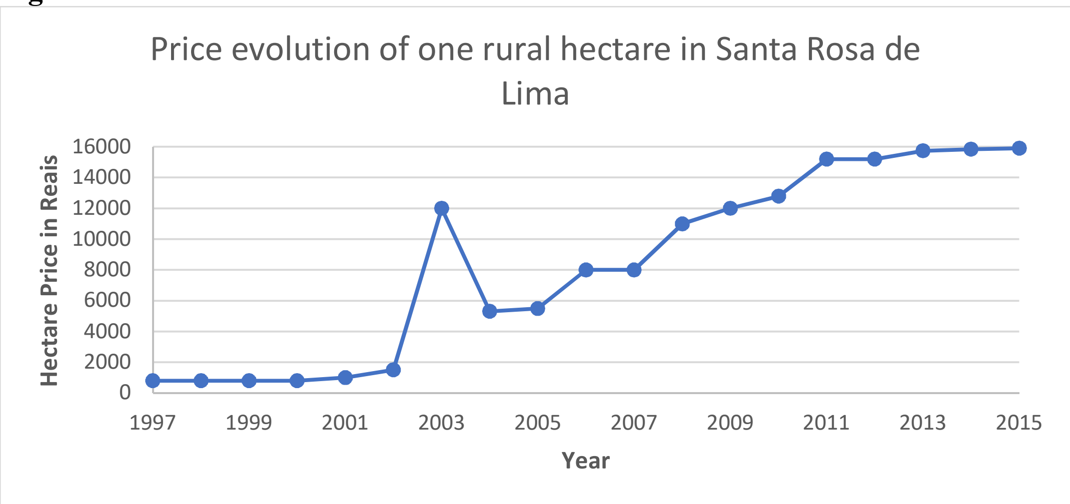
The higher spending on rations per animal unit on MIG farms was not expected, since the adequate application of the four MIG system laws for pasture management promises to ensure sufficient pasture availability, therefore eliminating the need for purchasing rations in order to achieve high profits. According to Martin (1997), pasture is the main component of dairy diets. The use of concentrate for MIG farmers could be due to inadequate management of the system. According to Parker, Muller and Buckmaster (1992), if pasture is poorly managed, more stored forages and concentrates are required to compensate for the lowest feed quality of the pastures. According to field observations, it was determined that not all of the farmers are applying all the MIG laws, for example, just two MIG farmers were applying the Maximum Yield law, in which the animals with more nutritional demand, lactating cows for example, should be the first to graze a paddock to get the upper pasture layer, which have better quality, and the animals with less nutritional demand, ie. calves, access the paddock later to graze the lower pasture layer. Additionally, it is possible that farmers are afraid to reduce cows' productivity, since an excellent grass quality that can generate high yields of milk production is not easy to achieve (MARTIN, 1952). It has to be considered that farmers are not just concerned with feeding animals, but with reaching the highest level of milk production. However, based on the economic efficiency approach, achieving more for less is a goal, and the higher costs due to purchased feed did not generate a confidently high enough animal productivity for MIG farmers, as there was no statistically significant difference between the systems.

MIG farmers demonstrated less use of silage per heifers and cows than non-MIG farmers. On one hand this appears to be an agroecologically positive characteristic, because we could conclude that the animal diet is based more on pasture. However, this could also represent more dependence on external inputs if the difference in silage use is being compensated for purchased rations, which seems to be the case for MIG farmers in our sample. Silage is produced by the farmers. They grow corn crops and prepare the silage on the farm once a year for the entire year. It is known that for this crop, they also sometimes depend on external inputs such as corn seed, chemical fertilizers and herbicides. Therefore, if it is necessary to complement the animal diet, it is preferable to do so with silage, and preferably not using herbicides or chemical fertilizers. This would reduce the costs of silage production, and decrease even more the reliance on external inputs.

According to the results of the indicators of profitability, MIG farmers carry the advantages for Net Income I/hectare, Net Income II/hectare and animal unit, and ROA I, II and III over non-MIG farmers. It is important to mention that in reality MIG farmers presented higher Net Income for any method of calculation (Net Income I, II and III) and denominator of normalization (hectare, liter and animal unit), except for Net Income I/liter. However, the significance of the difference was just confirmed for Net Income I/hectare, Net Income II/hectare and animal unit, so it is rational to emphasize these indicators with regards to MIG system's success.

The Return on Investment was higher for MIG farmers, but it was still very low with regards to the interest rate on savings for the period, in general, due to the high investment on assets of the activity. It means that farming does not even compete with keeping money in a savings account. One explanation is that farmers simply enjoy their work and can sustain themselves on it, so maximizing monetary returns is not their main goal. Farmers are well known for exploiting themselves (GALT, 2013.) Another possibility is that land values are increasing rapidly, so maintaining ownership of the farm is important. The **figure 2.4** shows the price evolution of one hectare of land in Santa Rosa de Lima[34]. It shows an increase of 1888% in the land price in the municipality between 1997 and 2015, this is much higher than the saving account accumulated interest rate for the same period (407,46%)[35].

Figure 2.4 −Price evolution of one rural hectare in Santa Rosa de Lima



Source: Epagri/Cepa 2016.

[34] Epagri provides different prices for five categories of land. We are here showing the price evolution of the best quality category of land for agriculture.
[35] Information obtained from the "citizen calculator" available on the Central Brazilian Bank website (www3.bcb.gov.br).

The BCR, on the other hand, seems more economically attractive for both farming systems, as it covers investment in the production process and possible returns from savings accounting, except for Non-MIG farmers in the cost II and III calculation methods.

It is also interesting to compare some results of Santa Rosa de Lima farmers (both individually as well as the average of MIG and Non-MIG) to the results of the Tubarão Microregional (TM)[36] and Santa Catarina (SC) state.

Table 2.10 − Characteristics of Santa Catarina, Tubarão Microregional and Santa Rosa de Lima (SRL) Dairy Farms[37]

Variables/average	*Santa Catarina*	*Tubarão Microregional*	*SRL*	*MIG*	*No-MIG*
Pasture area (ha)	8	11.87	10.25	11.45	8.75
Crop area (ha)	2.6	2.92	4.02	4.40	3.54
Dairy area (ha)	10.6	14.79	14.27	15.85	12.29
Number of cows	17.4	30	18.7	23.33	12.92
Cows/hectare of pasture	2.18	2.53	1.82	2.30	1.57
Cows/hectare of dairy area	1.64	2.03	1.31	1.61	1.13
Cow productivity (liter/cow/day)	13.58	16.1	11.34	12.38	10.06

Source: Santa Catarina and Tubarão Microreginal data were provided by Epagri. Own elaboration.

As shown by **table 2.10,** the area of pasture of SRL is smaller than that of TM, but is bigger than that of SC dairy farms. The crop area of SRL's farmers is higher than both SC or TM overall, and the total dairy area is higher for SRL than for SC as a whole, and on par with TM. SRL's farmers have more cows than all SC farmers on average, though fewer than TM farmers on average. The stocking rate of cows of SRL is smaller than SC and TM for pasture area, as well as for the total dairy area. Finally, the productivity (milk liter/cow/day) is smaller for SRL than for SC and TM. This data shows that SRL has a lower efficiency in animal milk production than Santa Catarina State and the Tubarão Microregional, which thus demonstrates a need for improvement in this performance variable.

[36] The Tubarão Microregion is formed by 20 municipalities located in the south of the state of Santa Catarina, and includes the Santa Rosa de Lima municipality. Its total population is about 375,000 people. Santa Rosa de Lima represents 0.5% of Tubarão Microregion population (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2010).

[37] The data related to Santa Catarina and Tubarão Microregional were provided by Epagri in July of 2015. The sample of Santa Catarina State is N= 56188 farmers, and Tubarão Microregional's sample is N=15 farmers. Data on SRL are from the accounting project, obtained in July of 2014.

2.5 CONCLUSIONS

The Management Intensive Grazing system (MIG) is an alternative management intensive grazing system for the conventional dairy systems in the south of Brazil. This system has demonstrated to have a high potential for the transition to an agroecological system, since the suitable management of the pasture, cattle and soil makes the use of external inputs, such as fertilizer and purchased feed, unnecessary or less needed. In the study case of Santa Rosa de Lima, in the state of Santa Catarina, the MIG system cannot be considered a true agroecological system, nor a fully organic system, since there is still common use of fertilizer and non-organic purchased feed. However, the reduction of input use per production unit shows that MIG farmers in Santa Catarina can be in the path for this transition.

According to Gliessman (2016), there are five levels in the conversion process from conventional agricultural practices to agroecological practices. These three levels are: 1) Increasing the efficiency of conventional practices in order to reduce the use and consumption of costly, scarce, or environmentally damaging inputs; 2) Substituting conventional inputs and practices with alternative practices; 3) Redesigning the agricultural system so that it functions on the basis of a new set of ecological processes; 4) Re-establish a more direct connection between those who grow our food and those who consume it; and 5) Build a new global food system, based on equity, participation, democracy, and justice, that is not only sustainable but helps restore and protects earth’s life support systems upon which we all depend.

The MIG system can provide the conditions for the transition, so that these five levels can be achieved. It is important to mention that the first step for this transition for farmers in Santa Rosa de Lima was to become aware and to apply the MIG system, which demanded time and knowledge. To implement the system, they had to divide all pasture area in paddocks using electric fences, develop a hydraulic system to provide water for the animals, and other labor and resource intensive changes for their farms. When fencing in the paddocks, they also saw the chance to improve pasture through the insertion of new gasses and leguminous plants. All these factors considered, the implementation of the MIG system requires a large amount of time to be set up. The MIG farmers have still not fully reached the first level mentioned by Gliessman (2016), but they seem to be heading in this direction. With the exception of herbicide use and purchased feed, the MIG systems present lower costs in the use of inputs. For some variables, this difference was not statistically significant because the variation of these values among MIG farmers (standard deviation) was high. It is expected that this variation will decrease with improvement of the system over time, and this difference will be statistically significant for our sample. In addition, for the majority of the indicators of profitability, MIG system showed better performance than the Non-MIG system.

Once MIG farmers reach the first level in Gliessman's agroecological conversion process, the environmental advantages of this system will appear in following levels. However, to guarantee the continuation of this gradual process, other factors would be helpful, such as financial incentives and the improved transferring of knowledge. In this aspect, the government, scientists and technicians will play an important role. The transformation towards an agricultural system that is economically viable, more sustainable and less environmentally degrading can be achieved with the right combination of diversified interests, varied expertise and a combination of power.

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CHAPTER 3

A SUSTAINABLE INTENSIFICATION APPROACH AS A MEANS TO ACHIEVE FOREST CONSERVATION, FOOD PRODUCTION AND SUSTAIN ECOSYSTEM SERVICES IN BRAZILIAN SOUTHERN ATLANTIC FOREST

3 SUSTAINABLE INTENSIFICATION APPROACH AS A MEANS TO ACHIEVE FOREST CONSERVATION, FOOD PRODUCTION AND SUSTAIN ECOSYSTEM SERVICES IN BRAZILIAN SOUTHERN ATLANTIC FOREST[38]

Abstract

Brazil's Atlantic Forest is a biodiversity hotspot that has lost about 88% of its original forest cover. Failure to restore forest cover could result in a catastrophic loss of biodiversity and ecosystem services. In Santa Catarina state, much remaining forest is highly fragmented and privately held. Efforts to restore forest must address the tradeoffs facing family farmers, many of whom seek to maximize production of milk, tobacco, and other crops. Sustainable intensification has been promoted as a means to balance economic and ecological objectives, allowing existing land in production to be used more intensively while freeing up land for reforestation. In this paper, we combine literature review and empirical analysis to evaluate the ways in which an agroecological practice – Management Intensive Grazing (MIG) – can contribute to sustainable intensification in Santa Rosa de Lima, in southern Brazil. This system has potential to increase dairy productivity, reduce reliance on off-farm inputs, improve pasture diversity and quality, mitigate erosion, sequester carbon, and improve soil heath. By increasing stocking rates and milk yields, farmers may be able to keep land out of production without an economic loss. Our results show that farmers adopting MIG perceived improvement of the environmental aspects of the dairy agroecosystem, improved their economic performance, but did not reduce external inputs such as animal feed and herbicide. On forest conservation, both MIG and non-MIG farmers are not protecting sufficient forest to meet legal requirements or the needs of biodiversity and ecosystem services protection. However, MIG farmers protected more areas of permanent preservation (APP) than non-MIG farmers. Forest cover appears to have increased since the MIG implementation in the region and pasture area decreased, which may be the result of a more efficient dairy system. A critical review of the implementation of this system suggests several aspects of the sustainable intensification model that need further analysis: how to reduce farmer reliance on inputs; how to cost-effectively monitor ecosystem service provision; and how to couple intensification with conservation absent strict regulatory enforcement or a payment-for-conservation model. Despite these questions, our analysis suggests that agroecological systems such as MIG may contribute to sustainable intensification, with potential benefits for biodiversity conservation and dairy production in the region.

Key-words: Sustainable intensification, biodiversity conservation, dairy food production, management intensive grazing, Atlantic Forest.

[38] This paper will be published with the contributions of Michael Wironen, Alison Adams, Joshua Farley, Paulo Antonio de Almeida Sinisgalli, and Abdon Schmitt.

3.1 INTRODUCTION

The Atlantic Forest (*Mata Atlântica*) biome covers approximately 1.1 million km² along Brazil's Atlantic coast, bordered by the Pampa to the south, the Caatinga to the north, and the Cerrado to the west (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2004). The biome is home to more than eight thousand endemic plant species and 654 endemic vertebrates (MYERS et. al, 2000). It is considered an international priority ("hotspot") for conservation due to the threats facing the region's biodiversity (idem).

Underlying the threat to the biome is the fact that more than two-thirds of Brazil's population resides in the Atlantic Forest biome (MINISTÉRIO DO MEIO AMBIENTE, 2017; SOS MATA ATLÂNTICA, 2017), leading to intense competition for land and resources. As a result, more than 88% of the original forest area has been lost due to deforestation and land conversion (BANKS-LEITE et al., 2014). Much of what remains is highly fragmented, with only 8.5% of the original area existing as forest fragments of at least 100 hectares. Its current forested area totals 162,666.4 km², which represents 12.4% of its original area (SOS MATA ATLÂNTICA, 2017)[39]. Only 2.7% of the original forested area is in a Unit of Conservation (UC) of Integral Protection, and 7.3% is in a UC of Sustainable Use, which includes managed areas such as pasture, crops, and urban areas (CADASTRO NACIONAL DE UNIDADE DE CONSERVAÇÃO, 2012; CUNHA; GUEDES, 2013).

To counteract the threat to biodiversity posed by historic land cover change, significant reforestation will be needed (BANKS-LEITE, et al., 2014). The challenge is balancing the need to reforest (and protect existing forest) with the need to provide livelihoods for the region's millions of residents. Small family farms[40] dominate the Atlantic Forest biome, occupying two-thirds of the land in the region and accounting for 50% of the family farms in Brazil (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, apud PORFÍRIO, 2013). Family farmers face

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[39] SOS Mata Atlântica considers the original area of the Atlantic Forest to be 1.31 million km², 210 thousand km² more than Instituto Brasileiro de Geografia e Estatística and Ministério do Meio Ambiente's measurement.

[40] According to Brazilian Law nº 11.326/2006 (BRASIL, 2006b), a family farm is defined as a farm that consists of four or fewer productive units (módulo fiscal), where the family works and coordinates the activities in the property, and in which most family income is derived from agricultural activity. The size of a productive unit varies regionally, ranging from 5 to 110 hectares based on an estimate of the minimum land area needed for economically viable production (LANDAU et al., 2012).

challenges in managing their land profitably, maintaining productivity, and protecting natural resources by complying with Brazil's forest code (SCHMITT et al., 2013). The small size and sheer abundance of properties also complicates conservation efforts. Developing policies that successfully balance the competing goals of profitability, food production, employment, and conservation is central to reduce and, hopefully, reverse the loss of the Atlantic Forest.

In this paper, we use a case study from Santa Rosa de Lima (SRL), in Santa Catarina State, Brazil, to critically evaluate whether and how sustainable intensification can be used as a means to improve agricultural yield while restoring and/or protecting natural capital in the Atlantic Forest. First, we provide context on the policy environment, specifically the Brazilian forest code; second, we critically review the literature on sustainable intensification, highlighting key claims and arguments, some of which we evaluate in our study; third, we describe the study site and the proposed approach to sustainable intensification, namely introducing management intensive grazing (MIG) into a dairy-dominated agricultural system, something underway in the study area since the late 1990s (ALVEZ et al., 2014); fourth, we describe the research methods and design; fifth, we present results related to the farmers interviews and land cover changes in SRL; and finally, we discuss the results in light of our earlier review of the sustainable intensification literature, presenting lessons for future implementation. Our analysis provides valuable insight regarding the design and implementation of agroecological and conservation policy and practices.

3.1.1 Forest protection and the Brazilian forest code

Brazil's Forest Code entered force through the Law Nº 4771 in 1965 with the goal of ensuring the preservation of some native forest on rural properties (CUNHA, 2013). In 2012, after many alterations to Law Nº 4771 and much debate, the law was revoked and the current Brazilian Forest Code was established through the Law Nº 12.651/2012. This law requires that rural properties in the Atlantic Forest biome maintain 20% of their total area in native vegetation as a Legal Reserve

(LR)[41]. Additionally, this Law designates certain Areas of Permanent Preservation (APP)[42]. The APP includes riparian areas, areas around springs and lakes, hilltops, steep slopes, and areas of high elevation (BRASIL, 2012b). Land that is considered APP can count towards a landowner's LR requirement, but the LR cannot be fragmented.

In order to provide some flexibility for small farmers the Law Nº 12.651/2012 relaxes some requirements for the APP and LR. For family farms that had agrosilvopastoral, ecotourism and rural tourism activities in place before 2008, the required riparian, lake, and water source buffers (APP) have been relaxed to 5 – 15 meters, depending on the number of productive units[43] (BRASIL, 2012b). For non-family farms, this requirement ranges between 30 and 600 meters, depending on river width. Critically, family farms that did not meet LR requirements for native vegetation cover prior to the new forest law do not necessarily need to re-vegetate to achieve compliance. They can achieve compliance by some other means, for example, the requirements of the LR can be met through alternative mechanisms such as leasing another farmer's excess LR, donation for conservation of additional private land within Conservation Units, and other methods that allow for "land trading" within the Atlantic Forest biome (BRASIL, 2012b).

The main means for assessing compliance and enforcing the Forest Code is through obligatory registration in the national Environmental Rural Registration System (Cadastro Ambiental Rural-CAR)[44]. Each farmer must declare how much of their land is in LR and APP while committing to restore additional land if they are not in full compliance. Without this registration, landowners are not able to sell, subdivide, or transfer the land (even via inheritance), nor can they access some government benefits or participate in certain payment for ecosystem services programs (BRASIL, 2012a). Additionally, in the case of the Atlantic Forest, the Law Nº 11.428/2006 prescribes a

[41] LR is the area located inside of a property or rural tenure with the function of ensuring the sustainable economic use of natural resources in the rural property, supporting the conservation and rehabilitation of ecological processes and promoting the biodiversity conservation, as well as the habitat and protection of wildlife and native flora (Brazil, 2012).
[42] APP is protected area, covered or not by native vegetation, with the environmental function of preserving the hydric resources, the landscape, the geological stability and the biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations (Brazil, 2012).
[43] Productive unit (modulo fiscal) is a measure unit, in hectares, which is set for each municipality taking into account: (a) the type of predominant economic activity in the municipality; (b) the income obtained in the predominant type of economic activity; (c) other activities existing in the municipality which, although not predominant, are expressive according to the income or area used; (d) the concept of "family ownership". The size of a productive unit varies according to the municipality where the property is located. The value of the productive unit in Brazil ranges from 5 to 110 hectares (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2018).
[44] CAR is the national public electronic registration system designed to integrate environmental and cadastral information regarding rural properties for monitoring, planning, and combating deforestation (Brazil, 2012).

penalty (imprisonment or fine) for those who commit environmental crimes against the biome (BRASIL, 2006a). Committing environmental crime can block the access of a landowner to some government benefits, incentives, and credits (BRASIL, 2008).

Although the law (Decree Nº 7.830/2012) mandates monitoring of compliance by the State environmental departments, which are part of the National Environmental System, it is not clear how much monitoring occurs. Verifying and enforcing compliance is difficult and inconsistent.

3.2 A CRITICAL REVIEW OF SUSTAINABLE INTENSIFICATION

Sustainable Intensification (SI) is a strategy which aims to raise agricultural productivity while reducing environmental impacts (BOURGEOIS, 2013; GODFRAY; GARNETT, 2017; FRANKS, 2014, PRETTY, 1997). SI is also interpreted as producing more food, using the same amount of land, with fewer resources (VETERINARY RECORD, 2014; BOURGEOIS, 2013; GODFRAY; GARNETT, 2017). Godfray and Garnett (2017) state that in the SI approach increased production must play at least some role in meeting the food security challenge, and increasing the sustainability of food production has to be a goal in the SI approach.

If agricultural land can be used more efficiently, forests and grasslands can be spared from conversion into agriculture and marginal farmland can be abandoned and eventually restored to native vegetation, absent any other feedbacks. Considering the advanced level of loss, fragmentation, and degradation in the Atlantic Forest landscape, preserving existing habitat and restoring the landscape structure is necessary to conserve biodiversity and ecosystem services in the long-term (CUNHA; GUEDES, 2013). As Joly, Metzger and Tabarelli (2014) has noted, the Atlantic Forest is at risk of ecosystem collapse and catastrophic loss of biodiversity due to the magnitude and extent of deforestation. This could impact the long-term viability of the ecosystem services that the region's 145 million inhabitants depend on.

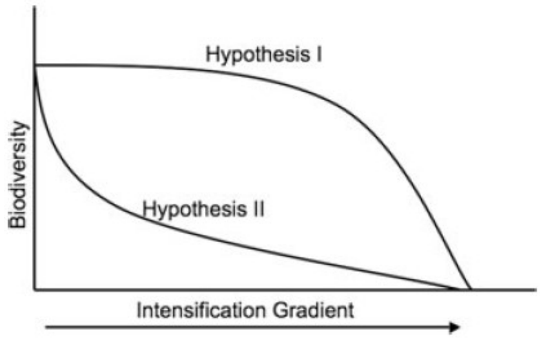
It is in this context that we critically assess efforts to use sustainable intensification as a means to achieve forest conservation and sustain ecosystem services, while providing conditions that promote farmer livelihoods in the Atlantic Forest. Sustainable intensification has been written about extensively in the academic literature, and much can be gleaned from the debates surrounding its application and utility. In this section, we review the sustainable intensification literature with regard to several central questions of relevance to Santa Rosa de Lima and the Atlantic Forest: first, can sustainable intensification achieve conservation via land sparing?; second, how do market access and feedbacks affect the outcomes of sustainable intensification initiatives?; third, what exactly makes intensification sustainable?; and fourth, what does sustainable intensification mean for farmer livelihoods?

3.2.1 Sustainable intensification as a means to achieve conservation: Sparing versus Sharing

Sustainable intensification is seen by some authors as a possible means to achieve land sparing, i.e. preventing “wild nature” from being placed into production by increasing yields on existing farmland (Garnett et al. 2013). The debate on land sharing versus land sparing has received attention due to the challenge of balancing the goals of producing more food and conserving biodiversity. In the literature there are many defenders of both approaches (HULME et al., 2013; PHALAN et al., 2011; TSCHARNTKE et al. 2012; PERFECTO; VANDERMEER, 2008). We also find some who report that the gains from the application of one or another approach will depend on the context; for example, the amount of non-crop habitat in the landscape matrix (EGAN; MORTENSEN, 2012).

The land sparing discourse is motivated by concerns that agricultural production will need to increase to meet the needs of a growing population, requiring new land to be brought into production (Godfray et al. 2010). The approach argues that shifting land into agriculture will drive to loss of biodiversity, as opposed to intensifying the use of existing land and reducing land conversion (Phalan et al. 2011). This interpretation is shown in **figure 3.1** as hypothesis II (PERFECTO; VANDERMEER, 2008; TSCHARNTKE et al. 2012). In this, biodiversity falls dramatically as soon as natural habitat is disturbed by some agricultural intervention.

Figure 3.1 − Two hypotheses based on the relationship between management intensity and biodiversity



Source: Perfect and Vandermeer (2008).

The land sharing discourse argues differently, in alignment with Hypothesis I in **Figure 3.1**. The land sharing discourse emphasizes that agroecosystems can be considerable reserves of biodiversity as well as providers of ecosystem services. This approach advocates that biodiversity declines less rapidly with low levels of intensification, with much higher levels of intensification required to yield dramatic declines. A key assumption is that the benefits of land sharing occur when production practices follow agroecological, or sustainable agriculture practices, with much debate around these terms (BOMMARCO; KLEIJN; POTTS, 2013; PERFECTO;VANDERMEER, 2010; PETERSEN; SNAPP 2015). A diverse "agroecological matrix" interspersed with stands of native vegetation may be able to sustain much greater biodiversity that a patchwork of small farms producing only a few crops, even if those crops are produced using low-input techniques.

In defense of land sparing, Phalan et al. (2011) present data suggesting that land sparing, in which high-yield farming is combined with protecting natural habitats from conversion to agriculture, is a better means for protecting biodiversity than land sharing (idem). What remains unclear is the geographic scale and pattern at which these results remain valid. Those arguing for land sparing have emphasized the importance of large, continuous protected areas for biodiversity conservation, especially for species with large ranges (so-called "umbrella species"[45]). These areas are in short supply in many places, including the Atlantic Forest.

[45] The concept has been used to provide protection for other species using the same habitat as the umbrella species. As the term implies, a species casts an "umbrella" over the other species by being more or equally sensitive to habitat changes. Thus, monitoring this one species and managing for its continued success results in the maintenance of high quality habitat for the other species in the area (BOSTON UNIVERSITY SUSTAINABILITY).

The landscape in Santa Rosa de Lima is a patchwork of native forest, plantation forest, and agricultural land, primarily pasture for dairy herds as well as some small-scale vegetable production. Forest fragments are relatively small and isolated or connected by narrow corridors. IBGE (2006) estimates that 20% of SRL's area is occupied by pasture. Pasture areas are not favorable to the maintenance of small mammal populations and the use of this area by other animal groups, because the frequent grazing drives away or kills some small animals and facilitates predation due to the low vegetation cover of the matrix (SANTOS, 2014). In this context, Perfecto and Vandermeer (2008, 2010) strongly emphasize that the quality of the matrix matters. "As agriculture becomes a dominant feature in tropical regions, the effective conservation of biodiversity will depend, not only on protected areas, but also on the agricultural matrix and in particular on how the systems within it are managed" (PERFECTO; VANDERMEER, p. 191, 2008). Perfecto and Vandermeer (2008) refer to that as high-quality matrices: land use systems that facilitates the migration of organisms from habitat patches. They state that by applying agroecological system of production, for example, it is possible produce food while: a) generate biodiversity of the agroecosystem, planned[46] and associated[47]; b) conserve biodiversity by facilitation of interpatch animals migration; and d) promote ecosystem services that the agriculture is depended on, such as pollination, natural protection from pests and diseases, and natural fertilization. The authors strongly emphasize that the quality of the matrix matters. Evidence suggests that the land use matrix around fragments of forest decisively influences in the maintenance and viability of the species and the provision of the ecosystem services inside of protected areas (CUNHA; GUEDES, 2013).

Even in the case that sparing may be better for biodiversity, this is only one of many environmental variables that matter. "Agricultural intensification is taken to be the transition from ecosystems with high planned biodiversity to low planned biodiversity and an increase in the use of agrochemicals and machinery" (PERFECTO; VANDERMEER, p. 179, 2008). The inputs that the intensive agro-industrial production system relies on (energy, fertilizers, pesticides, mechanical equipment) have an "embodied" environmental impact that occurred elsewhere. Additionally, the use of these inputs may compromise the associated biodiversity that, in many cases, also acts as

[46] Planned biodiversity, also called agribiodiversity, "is the collection of plants and animals that the manager has decided are part of the managed system" (Perfecto and Vandermeer, p. 179, 2008).
[47] Associated biodiversity is the group of "organisms that live or spend some time in the managed systems, but are not intentionally included there by the managers" (Perfecto and Vandermeer, p. 179, 2008).

functional biodiversity, such as pollinators (PERFECTO; VANDERMEER, 2008). Furthermore, water and air pollution (including greenhouse gas emissions) due to agricultural activities can impact biodiversity elsewhere.

The broader food system sustainability concerns are neglected in much of the debate surrounding sustainable intensification and “sparing versus sharing”, although recently several authors have pointed to the need for a more nuanced discussion that considers habitat connectivity, lifecycle impacts, and other sustainability concerns (LOOS et al. 2014; FISCHER, et al., 2014; PERFECTO; VANDERMEER, 2008; TSCHARNTKE et. al, 2012). Some even argue that the basic motivation for the question is contestable, noting that contemporary food usage is inefficient with one third wasted and a further third used to feed livestock (TSCHARNTKE et al., 2012). Critics also note that land is converted from native forest or grassland for a multitude of reasons, not simply food production (e.g. biofuels, timber, urbanization, mining). Perfecto and Vandermeer (2008) emphasizes that, besides the need of protected areas, the agrifood system needs a new conservation paradigm in which small farmers work with conservationists to promote a high-quality matrix that provides animal interpatch migration, and a sustainable and dignified livelihood for rural communities.

3.2.2 The role of market access and the price mechanism in shaping sustainable intensification outcomes

If sustainable intensification is successful, farmers will generate more output from a given parcel of land, increasing the supply of food on the market. According to the land sparing theory, this “frees up” land for other purposes, one being conservation. The mechanisms by which this occurs are frequently left unspecified and merit further elaboration.

In theory, increased supply should result in a drop in the price received per unit output. The extent to which a farmer’s net revenue will increase depends on the elasticity of demand. Insofar as we are talking about a small number of farmers increasing production of a widely-traded commodity, the impact on price is likely negligible, so we can assume that increased production yields a proportional increase in revenue. However, if the sustainable intensification model proves successful and is taken to scale, a price/revenue feedback can be expected, unless land is taken out of production or demand increases substantially.

Worryingly, absent a mechanism to take fallow land and place it under conservation, there is no means to ensure that land will actually be spared from production. Indeed, if sustainable intensification is successful and farmers have access to a large enough market, they may put their profit to use expanding the area under production. As highlighted by Kaimowitz and Angelsen, “in many contexts improved technologies, by making cattle production more profitable, will result in more forest being converted to pasture” (p. 6, 2008). In places such as Santa Catarina, where much of the agricultural production is for regional, national, and international markets (i.e., it is not solely for subsistence), this economic response can be expected, absent a means to ensure conservation outcomes. Even if agricultural land is spared, many farmers maintain monoculture stands of eucalyptus and/or pine to sell to timber companies, which may be another means of generating revenue from the land. Strategies to increase the profitability of agriculture in rural communities, e.g. development of value-added processing, may actually exacerbate pressure on fallow land by increasing profitability and market access.

Additionally, if farmers can increase revenue and profit from a given area of land under a specific crop via sustainable intensification, it frees up land for alternative production systems such as forestry or other crops. Diversification allows farmers to hedge risk. For relatively poor smallholders, given the market motives and feedbacks described above, it is unclear why sustainable intensification would in itself generate land sparing without being paired with a strong conservation program or regulatory system. Intensification will only spare land from production if it is paired with conservation; the link is not guaranteed.

3.2.3 What exactly makes intensification sustainable?

As with many concepts that invoke the concept of “sustainability”, sustainable intensification has not been immune to criticism that it is vaguely defined (PETERSEN; SNAPP 2015). Pretty (1997) initially defined SI as an approach, which argues that substantial growth is possible in current agricultural, land, unimproved land, and degraded areas whilst at the same time protecting or regenerating natural resources. The author seems to use sustainable intensification and sustainable agriculture to mean "more than a simple model or package to be imposed, but a process of learning" which aims at the integration of natural processes, the reduction of external and non-renewable inputs, the participation of farmers and other rural community members in the issues concerned to agricultural production, and diverse agriculture that draws upon traditional and scientific forms of knowledge. As Pretty (1997) envisages, sustainable intensification is designed to promote agroecological polycultures, which some evidence suggests can be more productive per hectare than conventional intensive production (ROSSET; ALTIERI, 1997).

Pretty (1997) mentions minimizing the use of external inputs due to the dependency and vulnerability that farmers are exposed to via reliance on external inputs, as well as the negative impacts of these inputs on the environment, but the author does not propose entirely eliminating the use of agrochemicals. The concept of SI as presented by Pretty (1997) is limited to the gates of the farm. This condition is strongly criticized by Bourgeois (2013), who states that the concept of SI must address the whole food system.

Bourgeois (2013) argues that the concept of SI strongly focus on productivity, yields, and intensification, and brings the idea of producing more with less, meaning that both absolute and relative dimensions are needed. The author argues that: the sustainability dimension is limited to natural resources and the environment; scientific knowledge has been emphasized, ignoring traditional and local knowledge; the focus on producing more with less ignores the way that it is produced; impacts are usually measures only on the short term; and global concepts are used that ignore local particularities. The author criticizes the use of neoclassical economic principles in a concept that was proposed to drive the current agricultural system to a new paradigm. Otherwise, he suggests to focus in the original aspiration of sustainable intensification: resilience and sustainability. For these reasons, the author suggests a reformulation of SI concept as intensified sustainability, in which the focus is shifted to sustainability and a more holistic understanding of what agricultural is about, such as nourishing people, creating healthy communities and sustaining the planet.

Given the production focus, it is unsurprising that many aspects of the broader food system remain unaddressed in the sustainable intensification discourse. The dependency of modern industrial agriculture on non-renewable resources (minerals, fossil fuels) is directly criticized, hence the emphasis on reducing off-farm inputs. The impacts of farming practices (soil loss, water pollution) are similarly considered. However, the sustainable intensification discourse does not address the particular choice of crops produced, post-harvest losses, the impacts of moving food to market, value-added production, or distributor/consumer waste, food efficiency for human nutrition, among other issues.

About the justification of SI as a means to feed the world, Perfecto and Vandermeer (2008, p. 182) question this target. The authors mentioned that “vague notions such as the calorie requirements of the world, have little to do with decisions that are made at the farm or even regional levels. Indeed, in most parts of the world, if there is a target it is to maximize return on investment”. On that, Tscharntke et al. (2012, p. 57) brings attention to the fact that, if SI is about feeding the world, “food security and food sovereignty need to increase where the hungry live, based on robust, eco-efficient approaches and agroecological intensification, which incorporates natural biodiversity patterns and processes”. Therefore, supporting small farmers has to be at the heart of sustainable intensification.

3.2.4 What does sustainable intensification mean for farmer livelihoods?

Family farms in Brazil are major employers, occupying only 24% of the agricultural land but employing 38% of the nation’s agricultural workers (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2006; 2012)[48]. By substituting human labor and intellectual capital for mechanized capital, family farms generate much greater employment per hectare and per unit output than agro-industrial farms. This is important in the context of Brazil, where the Governor of Santa Catarina declared that citizens face a tradeoff between “forests or slums” (SCHMIDT et al., 2013). Family agriculture that creates decent jobs can stem the flow of migrants to Brazil’s cities (and slums). Family agriculture has been responsible for 74.4% of Brazilian agricultural employment (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2006), and is responsible by the production of 70% of food consumed in the country (BRASIL,

[48] According to Instituto Brasileiro de Geografia e Estatística (2012), the number of people employed in the main metropolitan regions of Brazil in 2006 was 19,9 million. Also according to Instituto Brasileiro de Geografia e Estatística (2006), the number of people employed by the family farms activities in the same year was 12. 3 million.

2015). Agro-industrial systems that substitute human labor with fossil fuels cannot achieve this outcome.

If sustainable intensification can capitalize on intellectual (human) capital and labor to increase profitability and yield, it can help sustain rural livelihoods. To achieve this goal, the model for sustainable intensification would likely need to resemble that of the diverse polyculture or agroecological matrix, which achieves its high productivity through the careful application of scientific and traditional ecological knowledge.

A key component of sustainable intensification, as envisaged at its inception by Jules Pretty and others (PRETTY, 1997), is the idea of farmer participation, learning, and adaptation. Indeed, Pretty (p. 249, 1997) argues that sustainable agriculture is “a process of learning.” This learning process enables the valued use of local resources in lieu of imported substitutes, allowing for adaptation and innovation as conditions change (idem.). This important and radical idea has often been lost in subsequent discussion of sustainable intensification (LOOS et al., 2014). Insofar as intensification relies on the widespread use of purchased agro-industrial inputs, it is unclear to what extent a learning and adaptation process is occurring. Some evidence suggest that intensification programs that provide free or subsidized inputs achieve high rates of participation, but little or no farmer-led innovation, and do not persist once subsidies are removed (PRETTY, 1997). Input-intensive production may increase yield in the short-term, allowing land to be spared for conservation, the wider impacts and viability of this form of intensification remain unclear, and are unlikely to be sustainable on the long-term (LOOS et al., 2014).

3.3 RESEARCH APPROACH AND METHODS

In this section, we describe the study region, discuss the way in which sustainable intensification is occurring in the study region, and specify the research methods.

3.3.1 Study site: Santa Rosa de Lima, Santa Catarina state

Santa Rosa de Lima is a small municipality of approximately 2,000 residents located in the Encostas da Serra Geral region of Santa Catarina State, in southern Brazil (see **figure 3.2**). The terrain is mostly hilly and forested, with the municipality situated between two mountain ranges and bisected by a river valley. Like much of the interior of Santa Catarina State, the predominant occupation of Santa Rosa de Lima's residents is farming (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2010). Small family farms occupy the majority of land, with 75% of the municipality's population residing in rural areas outside of the urban center (idem.).

Figure 3.2 − Santa Rosa de Lima Location

Source: Google INEGI 2017

Agriculture has a long and varied history in Santa Rosa de Lima. This history is well documented by Schmidt (2000) and Moreno-Peñaranda and Kallis (2010). In the mid- to late-1800s, settlers from Europe (primarily Germany) began colonizing the area, displacing native practitioners of slash-and-burn agriculture (MORENO-PEÑARANDA; KALLIS, 2010). The municipality of Santa Rosa de Lima was established in 1905 (SCHMIDT, 2000).

Due to the topography and dense forest, the settlers avoided the plantation-style agriculture common in coastal areas of Santa Catarina, practicing instead a diversified agriculture suited to the difficult terrain (MORENO-PEÑARANDA; KALLIS, 2010). As motorized vehicles and improved roads enhanced market access, farmers began to shift production toward cash-generating commodities such as pigs and timber (idem.). Starting in the 1950s, tobacco farming began to spread, aided by an intensive program of outreach and extension support by the tobacco companies (idem.). Tobacco provided high cash returns per unit area, allowing farmers to enhance revenue while maintaining a diversity of crops; at the same time, intensive tobacco farming depleted soils and led to farmer health problems (idem.).

Starting in the 1990s, many farmers began shifting land from tobacco to pasture and silage for dairy, responding to a surge in demand for dairy products domestically and, more recently, internationally (ALVEZ et al., 2014). At the same time, other farmers in Santa Rosa de Lima began experimenting with organic production (primarily fruits and vegetables), marketing their goods through a local coop, Agreco (MORENO-PEÑARANDA; KALLIS, 2010).

In addition to Agreco, currently, the organic famers of Santa Rosa de Lima count on many coops and institutions to support them with production and commercialization, such as the Credit Cooperative of Encostas da Serra Geral Region (CRESOL), Agrotourism Association "Acolhida na Colônia", Learning Center of Agroecology (CFAE), ALIAR, and Cooperative of Ecological Farmers of Encostas da Serra Geral (COPERAGRECO) (WILSON SCHMIDT, personal communication, August, 2015).

At present, milk is the main agricultural commodity produced in Santa Rosa de Lima, with 53% of rural properties producing milk, which accounts for 73% of all agricultural production value in the municipality (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2006). Santa Catarina is a top-four producer in Brazil (SANTA CATARINA, 2017), which is currently the third largest milk producer in the world (ALVEZ et al., 2014).

In 2002 the first organic dairy coop (*Laticínio Geração*) of Santa Catarina was created with the support of Agreco. The *Laticínio Geração* produced organic cheese, however due to the lack of raw material and the seasonal demand[49], the dairy coop had to abandon organic production. Currently, there is no organic dairy production in SRL. Most dairy farms are semi pasture-based operations, with the primary source of nutrition being pasture, corn silage and concentrates. They use chemical fertilizer and pesticide, and most of them have their pasture area degraded due to poor

[49] Local schools were the main consumers of the coop products. The products were not ordered during the schools' vacations and holidays, making the demand for the coop products seasonal.

management. It is in this context that sustainable intensification is being evaluated as a strategy for improving yields and profits while protecting forests and ecosystem services.

3.3.2 Sustainable intensification in Santa Rosa de Lima

In the past two decades, considerable work has been undertaken in Santa Rosa de Lima to shift agricultural production practices toward lower-input systems that seek to conserve natural resources. These diverse efforts have been conducted under the auspices of organic agriculture, agroecology, agroforestry, silvopastoralism, and other concepts. What unites the efforts is an interest in improving yield while restoring and/or protecting natural capital. This fits within the paradigm of sustainable intensification, which seeks to “increase food production from existing farmland in ways that place far less pressure on the environment and that do not undermine our capacity to continue producing food in the future” (GARNETT; APPLEBY; BALMFORD, p. 33, 2013).

There is evidences that Sustainable Intensification has begun at the same time that many farms in Santa Rosa de Lima have transitioned some or nearly all of their active farmland into dairy production (Alvez, Filho, and Farley 2012). This transition has been driven in part by the decline of tobacco yields due to exhaustion of soil, perceived health and psychological impacts of tobacco farming, and a national effort to boost dairy production (ALVEZ; SCHMITT; FARLEY, 2012; MORENO-PEÑARANDA; KALLIS, 2010).

Recent research by Alvez et al. (2014) indicates that daily milk production per cow in Santa Rosa de Lima and neighboring communities is less than 10 liters/cow/day, close to what we found, 11.34 liters/cow/day, which is less than the average reported for Santa Catarina (13.58 liters/cow/day) and the Tubarão Region[50] (13.58 liters/cow/day)[51]. This suggests that there is much room for improvement in dairy management (including breeding) in Santa Rosa de Lima.

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[50] The Tubarão Microregion is formed by 20 municipalities located in the south of the state of Santa Catarina, and includes the Santa Rosa de Lima municipality. Its total population is about 375,000 people. Santa Rosa de Lima represents 0.5% of the Tubarão Microregion population (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2010).

[51] The data related to Santa Catarina and Tubarão Microregional were provided by Epagri in July of 2015. The sample of Santa Catarina State is N= 56188 farmers, and Tubarão Microregional’s sample is N=15 farmers.

This research focuses on efforts to achieve sustainable intensification via the introduction of Management Intensive Grazing (MIG), or Voisin Rational Grazing (VRG), a form of rotational grazing pioneered by Andre Voisin. Under MIG, farmers install fencing enabling the subdivision of their land into multiple paddocks. Cows are then rotated through the paddocks at a rate that is determined by the specific growth profile of the pasture grasses (VOISIN, 1988). The advantages of MIG, including economic gains, include soil conservation and amelioration, carbon sequestration, improved animal health, improved water quality, have been extensively documented (PARKER et al., 1992; HANSON et al., 2013; TAUER; MISHRA, 2006; GILLESPIE et al., 2009; WINSTEN, 2000; MELADO, 2007; MEURER, 2008; MURPHY, 1994; BAUER, 2009; FARLEY, et al., 2015), especially in temperate regions. Importantly, use of MIG can help rebuild soil organic matter stocks, restoring natural capital that eroded on many farms due to tobacco and other intensive crop production practices. The use of MIG can be considered an agroecological practice, in that it is based on a scientific understanding of the soil/pasture ecology, reduces reliance on off-farm inputs, improves animal health, builds soil, and can be integrated into diverse production systems (e.g. silvopastoral systems). The use of MIG is conducive to organic production as it enables farmers to greatly reduce their reliance on imported/purchased feed, fertilizers, supplements, and pharmaceuticals.

In Santa Rosa de Lima, MIG has been promoted jointly by the Federal University of Santa Catarina and Epagri, the Institution of Agricultural Research and Rural Extension of Santa Catarina, since the late 1990s. According to the Santa Rosa de Lima's City Hall, currently, 45% of dairy farms in the municipality apply the MIG system, and 55% apply the conventional continuous grazing system.

3.3.3 Research questions

This research is intended to investigate whether and how MIG has contributed to sustainable intensification in SRL. We are concerned with understanding if SI can lead to better economic and environmental outcomes, which we explore in two ways.

First, we compare a set of MIG and Non-MIG farms to understand:

a) Does MIG increase farm profitability?
b) Do MIG farms use fewer inputs?
c) Do MIG farmers report better environmental conditions on-farm?
d) Do MIG farmers have greater awareness of forest conservation laws and requirements?

Second, we examine land cover trends for the community of SRL as a whole, given the efforts over more than two decades to promote agroecological practices in SRL.

3.3.4 Research methods

In order to analyze the effects of applying MIG in Santa Catarina, interviews were conducted in Santa Rosa de Lima. In April and May 2013, we interviewed 41 dairy farmers: 21 farmers adopting MIG (MIG Farmers), and 20 farmers not adopting MIG (Non-MIG farmers). We asked questions about the social, environmental, and economic aspects of farm activity during the last 10 years, as well as questions about their understanding, concordance and compliance with the Brazilian Forest Code. Additionally, we conducted an accounting project that collected monthly data for one year (August/2013-July/2014), including information on costs, sales[52], income, debts and assets of the dairy activity of 27 farmers (15 MIG and 12 Non-MIG).

To analyze the differences between the two groups (MIG and MIG-Farmers), we used t-tests (T) for data that were normally distributed and the Mann–Whitney U test (U) for data that were identified as nonparametric. To test the normality of distributions, we applied the Kolmogorov-Smirnov test. Analyses were conducted using IBM Statistical Package for Social Sciences (SPSS) Version 24.

For the analysis of land cover change in Santa Rosa de Lima, growing season Landsat images were obtained for each of three time steps: 1996 (before the project started), 2005 (middle of the project), and 2014 (current). The images were radiometrically and atmospherically corrected, and then clipped to the boundaries of Santa Rosa de Lima.

[52] Sales of animals were also considered since it represents a sub-product of dairy production.

eCognition software was used to generate an algorithm to automatically differentiate forest from non-forest areas, and to distinguish plantation from native forest. A 4-5-3 band combination has been shown effective for distinguishing eucalyptus from native forest in Landsat images of Brazil (SONTER; BARRETT; SOARES-FILHO, 2014), so this band combination was used in eCognition. Some smaller patches of forest or plantation were likely not detected due to the 30-meter resolution of Landsat images, but large swaths—which are most important for biodiversity—were distinguishable using brightness and Normalized Difference Vegetation Index (NDVI). The eCognition rule set was modified slightly to accommodate different threshold values for each time step. GoogleEarth imagery is sufficiently high-resolution to distinguish native and plantation forests visually based on texture, so a selection of validation points were established in ArcMap and transferred to GoogleEarth for visual validation.

After native tree canopy and plantation tree canopy were categorized, an additional map was generated showing areas that changed to and from native forest and plantation forest. Statistics were run on each image in ArcMap to determine a percent native forest cover for each time step.

We calculated number of patches, mean area (ha) e mean euclidean nearest neighbor distance (m), using Fragstats v4.2 for two classification schemes, as follows: all forest lumped into one category (native and planted forest); and forest classified into two categories: plantation forest and native forest.

3.4 RESULTS

3.4.1 Improving farmer livelihoods

To analyze the improvement of farmers’ livelihood due to MIG system, we compared some social and economic variables between the two groups of farmers, MIG and non-MIG. The variables considered were profit per animal unit, profit per liter of milk, Benefit Cost Ratio, Return on Assets, cow productivity, and land productivity. All these data derive from the accounting project (AP). Based on farmer perception, we compared the herd size increase, animal productivity increase, and improvement of family's life quality; these data were collected through the interviews (I), see **table 3.1**.

Table 3.1 − Comparison of livelihood variables between MIG and Non-MIG farmers

Variable	*Average or Percentage*		*p-value*	*N*		*Test*	*Source*
	MIG	**Non-MIG**		**MIG**	**Non-MIG**		
Profit (R$/month/animal unit)¹	**21.49**	**-22.80**	**0.073***	**15**	**12**	**T**	**AP**
Profit (R$/liter of milk)	**0.02**	**-0,25**	**0.193**	**15**	**12**	**T**	**AP**
Benefit Cost Ratio (R$ income/cost)	**1.17**	**0.94**	**0.143**	**15**	**12**	**T**	**AP**
Return On Assets (R$ profit/assets)	**0.03**	**-0.01**	**0.026***	**15**	**12**	**T**	**AP**
Cow productivity (Liter/cow/day)	**12.38**	**10.06**	**0.128**	**15**	**12**	**T**	**AP**
Land productivity (milk liter/month/hectare)	**426.78**	**237.24**	**0.066***	**17**	**15**	**T**	**AP**
Percentage of farmers that perceived herd size increase	**90**	**75**	**0.194**	**21**	**20**	**U**	**I**
Percentage of farmers that perceived animal productivity increase	**100**	**85**	**0.069***	**21**	**20**	**U**	**I**
Percentage of farmers that perceived that MIG increased family's life quality	**100**	**NA**	**NA**	**21**	**NA**	**NA**	**I**

AP – Accounting Project
I- Interview
NA- Not applicable
****significance at α = 0.10***
¹Exchange rate: R$2.24 to US$1.00.
Source: Own elaboration.

Profit calculated per animal unit and liter of milk were considerably higher for MIG farmers; the relationship was significant only for profit per animal unit, with a p-value of 0.073.

For Benefit Cost Ratio, which represents the relative returns (income) from a unit of money invested in production, MIG farmers showed better performance than Non-MIG farmers, but it was not statistically significant. The Return on Assets, which shows the return on profit for each monetary unit of investment on assets, was significantly higher for MIG farmers, however it was lower than the prevailing Brazilian interests rates for a savings account during the period (0.0616).

When asked about the increase in animal productivity in the last 10 years, one hundred percent of MIG famers stated that it had increased, more than the Non-MIG farmers (85%). When the animal productivity (production of milk in liters per cow per day) was compared using the collected accounting project data, animal productivity of MIG farmers was higher, but not statistically significant.

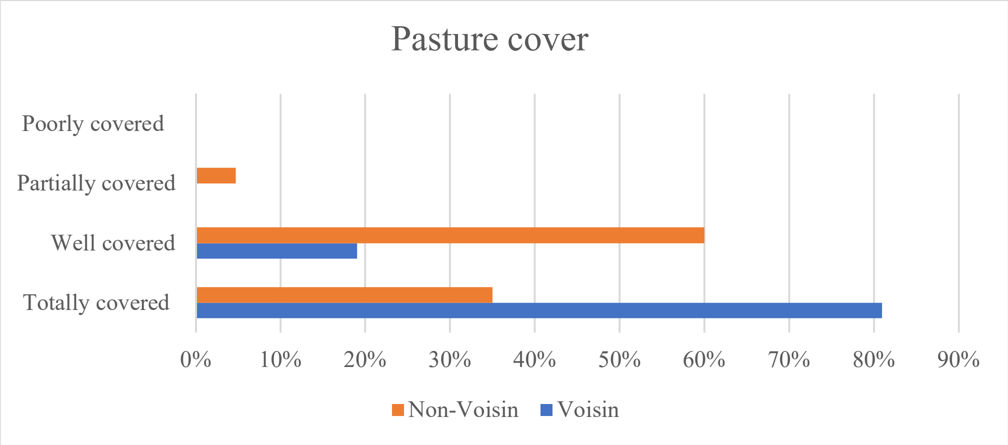
In general, MIG farmers were satisfied with the MIG system, stating that their family's life quality had improved since the system adoption. However, the majority of farmers interviewed showed no interest in organic production. Some former organic milk farmers mentioned that the price received for the organic milk did not compensate for the difficulty in producing it. Among 41 interviewed farmers, only 10% mentioned they had interest to produce organic milk.

3.4.2 Reducing the use of inputs

A central claim of MIG is that it enables farmers to reduce their reliance on externally supplied inputs, such as animal feed, veterinary medicine, fertilizers, and, additionally, labor requirements (PARKER et al., 1992; HANSON et al., 2013; TAUER; MISHRA, 2006; GILLESPIE et al., 2009; WINSTEN, 2000; PINHEIRO MACHADO, 2004; MELADO, 2007). By using fewer inputs, farmers can lessen their expenditures, hopefully improving profitability. By reducing the use of fertilizers, among other inputs, farmers can reduce their impact on water quality, biodiversity and carbon emissions.

Empirical evidence, summarized in the **table 3.2**, suggests that farmers practicing MIG in Santa Rosa de Lima are spending more on animal feed than Non-MIG farmers. Since increased density and quality of forage swards is expected in MIG systems (PINHEIRO MACHADO, 2004), this result surprised us. This is especially surprising since MIG farmers perceived better grass cover than Non-MIG farmers (see **figure 3.3**). 81% of MIG farmers stated that his/her area of pasture is totally covered, while the majority of Non-MIG farmers (57%) stated that his/her area of pasture is well covered, but not totally covered by grass. In view of this, or MIG farmers are feeding animals unnecessarily, or Non-MIG farmers have animals malnourished, since both have majority the same livestock breed (Jersey cattle), so, same nutritional demand. The amount of feed consumed by the cows and heifers was also higher for MIG farmers, but this difference was not statistically significant (see **table 3.2**).

Figure 3.3 – Pasture Cover



Source: Own elaboration.

On silage, Non-MIG farmers are feeding cows and heifers 36% more silage than MIG farmers. This difference showed statistical significance, with a p-value of 0.067. It shows that, while MIG milk production has relied more on animal feed, Non-MIG milk production relies more on silage, besides pasture. The spending on seed and seedling for animal diet did not showed statistical difference between the two groups.

On fertilizer use, MIG farmers showed less spending per hectare than Non-MIG farmers, but the difference was not significant. The percentage of farmers using fertilizer was statistically higher for MIG farmers than Non-MIG farmers, 80% and 35% respectively.

On herbicide use per hectare, MIG farmers are spending more than Non-MIG farmers. This difference showed statistical significance with a p-value of 0.058. The percentage of farmers using these chemicals in pasture areas was also higher for MIG farmers; however this difference was not statically significant. The use of chemicals is still very motivated by the expectation and anxious for fast results. Additionally, “farmers do not entirely trust on extensionists that bring agroecological practices to replace the use of chemicals. The trust has to be built with the recurrent presence of these extensionists and the massive involvement of farmers in debates about the topic” as stated by Wilson Shmidt, farmer and philosopher, who was born and raised in SRL.

Due to the rotation of animals among paddocks, reproductive cycle of the parasites is interrupted (UNDERSANDER et al., 2002), therefore fewer animal health problems are expected. The results in **table 3.2** showed that the percentage of farmers that perceived an improvement in the animal health is higher for MIG farmers, however the difference of spending on medication was not statistically different for both systems.

Table 3.2 − Comparison of inputs use between MIG and Non-MIG farmers

Variable	*Average or Percentage*		*p-value*	*N*		*Test*	*Source*
	MIG	**Non-MIG**		**MIG**	**Non-MIG**		
Rations (R$/month/animal unit)¹	**39.12**	**22.17**	**0.057***	**15**	**12**	**T**	**AP**
Rations (Kg/day/cow and heifer)	**1.65**	**1.05**	**0.181**	**15**	**12**	**T**	**Ap**
Silage (Kg/day/ cow and heifer)	**6.49**	**8.84**	**0.067***	**15**	**12**	**T**	**AP**
Seed and Seedling (R$/month/animal)	**4.12**	**3.68**	**0.611**	**15**	**12**	**T**	**AP**
Fertilizer (R$/month/hectare)	**15.90**	**21.56**	**0.406**	**15**	**12**	**T**	**AP**
Percentage of farmers using fertilizer on pasture area	**80**	**35**	**0.004***	**20**	**20**	**U**	**I**
Herbicide (R$/month/hectare)	**2.98**	**1.58**	**0.058***	**15**	**12**	**T**	**AP**
Percentage of farmers using herbicide on pasture area	**50**	**25**	**0.107**	**20**	**20**	**U**	**I**
Medication costs (R$/month/animal unit)	**3.45**	**1.95**	**0.323**	**15**	**12**	**T**	**AP**
Percentage of farmers that perceived reduction of animal health problems	**95**	**40**	**0,0001***	**20**	**20**	**U**	**I**

AP – Accounting Project
I- Interview
NA- Not applicable
****significance at α = 0.10***
¹Exchange rate: R$2.24 to US$1.00.
Source: Own elaboration.

3.4.3 Compliance with the forest code

While Santa Rosa de Lima has 62% of forest cover, the requirements of the Brazilian forest code are not fully met, particularly requirements related to the Area of Permanent Preservation (APP). Reforestation will be necessary to meet APP requirements and, in turn, provide suitable habitat to sustain biodiversity and critical ecosystem services (SOS MATA ATLÂNTICA, 2017). Enabling and encouraging this reforestation is a central challenge facing policymakers.

Given the predominance of small family farms and the requirements of the Forest Code[53], a typical landscape in full compliance would still likely resemble a patchwork mosaic of intact upland forests with small bands of connectivity along riparian corridors. In SRL, forest patches tend to be larger on hilltops and steep slopes; areas of gentle relief are usually in production. In an interview

[53] As previous mentioned, Brazilian Forest Code has more flexible requirements to small family farmers, which have less than four productivity unit.

conducted in 2015, Wilson Schmidt stated that the high percentage of native forest still remaining in Santa Rosa de Lima is due to the difficulty of using hilly areas for agriculture.

With the recent relaxation of the Forest Code, many farmers in Santa Rosa de Lima may only require a five-meter riparian buffer (in lieu of 30 meters) to be in compliance, which may encourage restoration of riparian areas to forest. But that do not provide any guarantee about the preservation and restoration of the natural conditions there is needed to ensure the provision of ecosystem services. Achieving connectivity is an important objective for conservationists. Thus, it is discouraging to note that research in Santa Rosa de Lima and throughout Santa Catarina state suggests that reforestation of riparian areas, particularly those in gently-sloped valley bottoms, will be difficult to incentivize absent stricter enforcement.

Alarcon et al. (2015) shows the impact on the provision of ecosystem services and land use and land cover due the relaxation of the environmental requirements in the Law Nº 12.651/2012. According to the authors (idem.), if complied with, the National Forest Act from 1965 would produce much more gains for forest ecosystem services than the National Forest Act from 2012, which would approach the baseline, contributing less to the provision of ecosystem services and biodiversity conservation. That is, the compliance of the Brazilian Forest Code of 2012 would not significantly change the current land use and land cover in Santa Catarina. In the context of the Atlantic Forest, the current legislation is insufficient to safeguard its unique biodiversity, which frailly persists (CUNHA; GUEDES, 2013).

Considering the National Forest Act from 1965 (Law Nº 4771) is better for ecosystem health and governed land use for nearly the entire period prior to the interviews in early 2013, farmers were asked about their compliance, knowledge and concordance on APP and LR according to the legal requirements before the relaxation of 2012 (Law Nº 12.651)[54]. We compared the results between farmers adopting MIG system (MIG farmers) and not adopting MIG system (Non-MIG) to evaluate if there is any difference between the two groups that may be influenced by the type of dairy system adopted.

About compliance with the Law Nº 4771/1965 on riparian area, we did not find significant difference between the two groups; neither are preserving this area as the law requires. The same

[54] The absence of GIS data delimiting parcel boundaries and ownership prevented an analysis on law enforcement for APP and LR at the scale of the individual farm.

was found on slopes of 45°, farmers are using some of this area for pasture, crop, or other activities. Both groups of farmers are not protecting these areas as the law requires. On water sources, we found more compliance with the forest code among Non-MIG farmers (27%) than MIG farmers (5%), and this difference was statistically significant.

In interviews, most farmers note that they do not agree on the Forest Code general requirements for riparian areas, water sources, areas of 45 degree slopes, which are all APP (**table 3.3**). The percentage of concordance for these areas was not different between farmers adopting and not adopting the MIG System. That suggests that both groups of farmers are indisposed to retire land from production in areas favorable for agriculture.

On concordance about Legal Reserve (LR), difference was found between MIG and Non-MIG farmers. The percentage of MIG farmers that agree with the LR requirement (62%) was higher than the percentage of Non-MIG famers (35%), see **table 3.3**.

The knowledge of farmers about the forest code requirements was similar. The percentage of farmers that knew the requirements, before our explanation, about riparian area and water sources was very low. Only 24% of MIG and 15% of Non-MIG knew the environmental law requirements for riparian areas and 24% of MIG and 20% of Non-MIG farmers knew the requirements on water sources, previously. But, most of them knew the requirements about areas of 45 degrees of slope (81% of MIG and 65% of Non-MIG farmers) and LR (86% of MIG and 85% of Non-MIG farmers), see **table 3.3**.

Table 3.3– Famers' knowledge and concordance on Brazilian Forest Code of 1965

Variable	*Average or Percentage*		*P-value*	*N*		*Test*	*Source*
	MIG	**Non-MIG**		**MIG**	**Non-MIG**		
Farmers that preserve riparian area as the law requires	5%	0%	0,317	20	20	U	I
Farmers that protect water source as the law requires	5%	27%	0,058*	20	18	U	I
Farmers that are protecting area of 45 degrees of declivity as the law requires	0%	6%	0,304	19	18	U	I
Know the code forest requirement for riparian area	24%	15%	0.482	21	20	U	I
Agree on riparian area requirement	10%	10%	0.338	21	20	U	I
Know the code forest requirement for water sources	24%	20%	0.771	21	20	U	I
Agree on water sources requirement	29%	25%	0.145	21	20	U	I

It continues

Continuation

Variable	Average or Percentage		P-value	N		Test	Source
	MIG	Non-MIG		MIG	Non-MIG		
Know the code forest requirement for area of 45 degrees of declivity	81%	65%	0.255	21	20	U	I
Agree on requirement for area of 45 degrees of declivity	5%	10%	1	21	20	U	I
Know the code forest requirement for Legal Reserve (LR)	86%	85%	0.949	21	20	U	I
Agree on LR requirement	62%	35%	0.091*	21	20	U	I

AP – Accounting Project
I - Interview
NA- Not applicable
**significance at α = 0.10*
Source: Own elaboration.

These results do not show significant differences between the two groups on compliance, knowledge and agreements on the National Forest Act from 1965 (Law Nº 4771/1965, except for the compliance on water source and agreement on legal reserve. So, even if MIG farmers have showed in some cases better performance, we cannot safely state that the type of dairy system adopted influences their compliance, knowledge and opinion on the environmental law, and *vice versa*. It deserves more attention.

The main reason that make farmers do not agree about some of Brazilian forest code requirements is that if they recover and protect these areas they would lose area for production; therefore they were asked about their interest in participating in Payments for Ecosystem Services (PES) programs to support compliance with the law. The results are shown in the **table 3.4**.

Table 3.4 − Willingness to participate in a PES program

Variable	*Average or Percentage*		*P-value*	*N*		*Teste*	*Source*
	MIG	Non-MIG		MIG	Non-MIG		
Willingness to receive to comply the riparian area requirement (sure, maybe)	**86%**	**65%**	**0.200**	**21**	**20**	**U**	**I**
Willingness to receive to comply with the water sources requirement (sure, maybe)	**90%**	**70%**	**0.226**	**20**	**20**	**U**	**I**
Willingness to receive to comply the requirement for area of 45 degrees of declivity (sure, maybe)	**86%**	**70%**	**0.381**	**21**	**20**	**U**	**I**
Willingness to receive to comply the LR requirement (sure, maybe)	**95%**	**70%**	**0.254**	**21**	**20**	**U**	**I**

AP – Accounting Project
I-Interview

NA- Not applicable
**significance at α = 0.10*
Source: Own elaboration.

The percentage of farmers interested in taking part of a PES program to support them to comply with the forest code (Law Nº 4771/1965) was higher for MIG farmers; however, this difference was not statistically significant. In general, most of famers were willing to participate in a PES program to comply the Brazilian forest code on APP and LR, which could be an alternative for policy makers to achieve the desirable native forest cover to ensure ecosystems services provision.

3.4.4 Environmental protection, biodiversity and ecosystem services provision

At present, no empirical data are available regarding sustainable intensification in Santa Rosa de Lima and its impact on biodiversity and ecosystem services. Based on farmers' perception, some evidence was found that suggests environmental advantages from MIG adoption, see **table 3.5**. MIG farmers reported better, statistically significant results for soil cover, soil biota, soil porosity and humidity. On soil biota, this environmental advantage would likely be higher if MIG farmers were not using chemicals on the soil, such as fertilizer and herbicides, as shown earlier in **table 3.2**.

About preservation of APP, the percentage of MIG farmers protecting riparian area and areas of 45 degrees of declivity in some way, according or not to the forest code, was higher than the percentage of Non-MIG farmers. However, for protection of water source, the percentage of Non-MIG farmers protecting these areas was higher, but not statistically significant.

Table 3.5 − Evidences on Environmental Conditions based on farmers' perception and actions

Variable	*Average or Percentage*		*p-value*	*N*		*Test*	*Source*
	MIG	**Non-MIG**		**MIG**	**Non-MIG**		
Farmers that have the pasture area completely or almost completely covered by grass	100%	95%	0.003*	21	20	U	I
Farmers that perceive any increase in the presence of little animals in the soil	55%	35%	0.064*	21	20	U	I
Farmers that perceive an improvement in the soil porosity in the last 10 years	75%	15%	0.0001*	21	20	U	I
Farmers that perceive an improvement in the soil humidity in the last 10 years	85%	20%	0.0001*	21	20	U	I
Farmers that protect riparian area in some way	100%	71%	0,000*	20	20	U	I
Farmers that protect water source in some way	65%	83%	0,94	20	18	U	I
Farmers that are protecting area of 45 degrees of declivity in some way	95%	78%	0,000*	19	18	U	I

AP – Accounting Project
I - Interview
NA- Not applicable
**significance at α = 0.10*
Source: Own elaboration.

On pasture diversity, MIG farmers reported greater pasture diversity than Non-MIG farmers. MIG farmers reported 55% and 35% more types of grass and legumes, respectively, than Non-MIG farmers. Both were statistically significant.

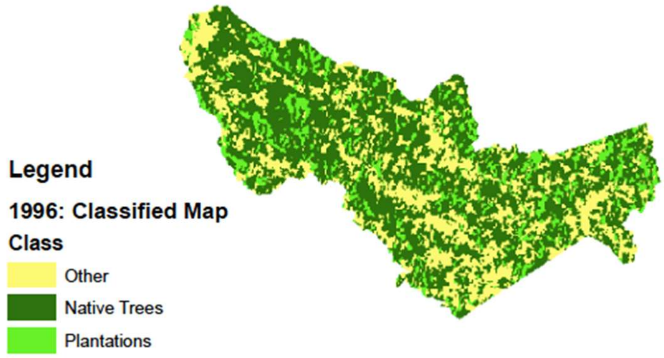
The results of perception on environmental improvements are an indication that farmers adopting the MIG system have better environmental performance in biodiversity and ecosystem services provision, which is expected.

3.4.5 Conserving native forest

Remote sensing data from 1996, 2005, and 2014 suggest that the forest cover in Santa Rosa de Lima has changed over years. Between 1996 and 2005 the percentage of total area covered by native forest decreased from 56,8% to 51,4%. Between 2005 and 2014 this percentage increased to 62,4%, with and approximately 18% of the remaining land area planted in Eucalyptus or Pine monoculture. The remainder of land is in pasture, crops, roads, or other built infrastructure.

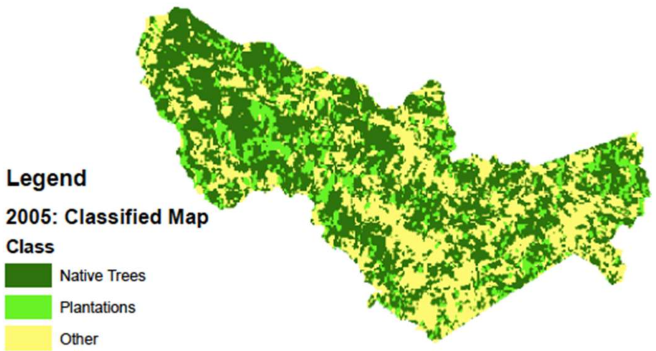
The land use maps of Santa Rosa de Lima for 1996, 2005 and 2014 are presented in the **figure 3.4, 3.5 and 3.6,** and the percentage of each category of land use are demonstrated in the **table 3.6**.

Figure 3.4 − Land Cover Maps of Santa Rosa de Lima for 1996.



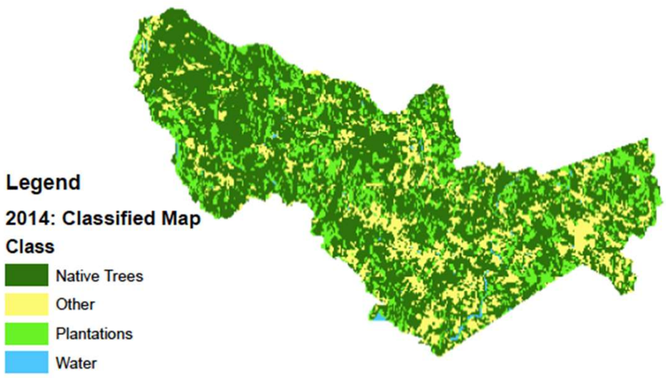
Source: Own elaboration.

Figure 3.5 − Land Cover Maps of Santa Rosa de Lima for 2005.



Source: Own elaboration.

Figure 3.6 − Land Cover Maps of Santa Rosa de Lima for 2014.



Source: Own elaboration.

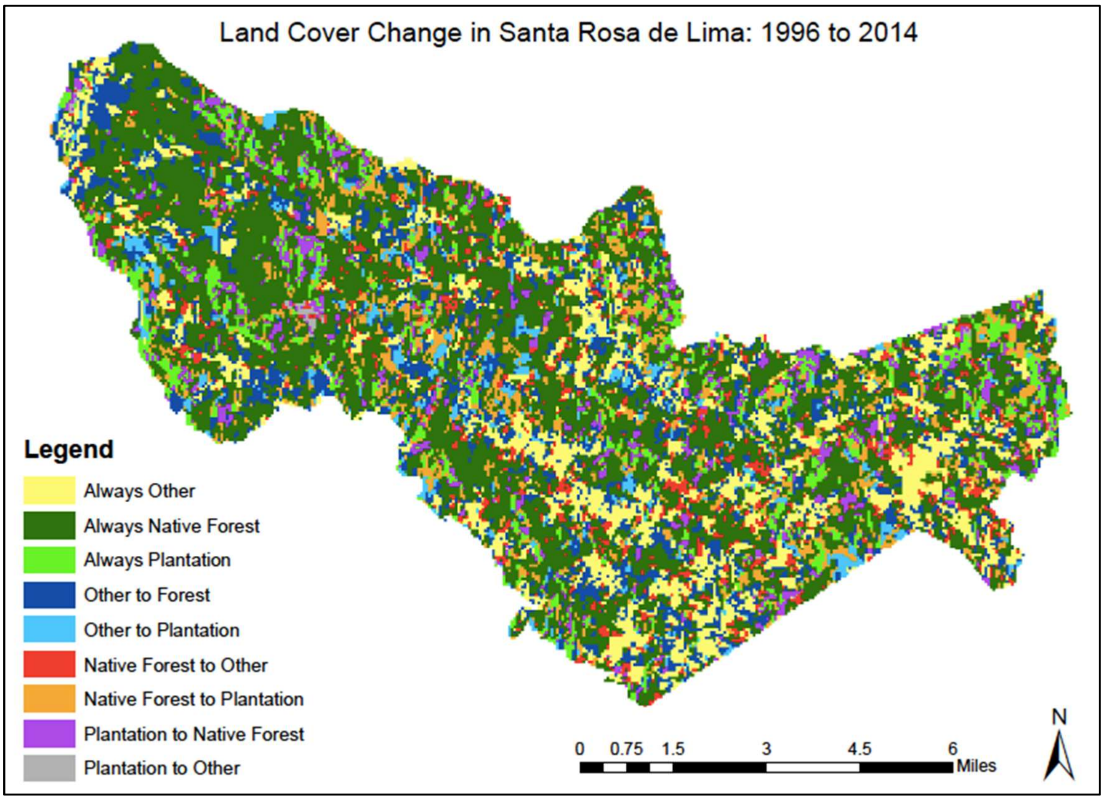
Table 3.6 – Percent Land Use Cover for Each Mapped Year

	1996	*2005*	*2014*
Percentage of native forest area	56.8 %	51.4 %	62.4 %
Percentage of planted forest area	12.6 %	12.7 %	17.9 %
Percentage of others area	30.6 %	35.9 %	19.7 %

Source: Own elaboration.

The non-forest (others) category drastically decreased between 2005 and 2014, being replaced mainly by native forest and, in sequence, by planted forest, as can be seen by the blue areas in **figure 3.7**. It is not possible to claim that the implementation of the MIG System in the region was responsible for the conversion of agricultural activities for native and planted forest, but this evidence suggests that further attention and research is needed, since milk production has increased 52% in the municipality between 2006 and 2010 (SEBRAE/SC, 2013)

Figure 3.7 – Land Cover Change in Santa Rosa de Lima between 1996-2014



Source: Own elaboration.

It is important to mention that the pasture area has decreased in all of Santa Catarina State since 1985[55], according to the Brazilian Institute of Geography and Statistics (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA, 2017) and the Brazilian Agricultural Research Corporation (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2014). There is no information about the application of the MIG system in the totality of the territory. Notably, additional to the decrease in pasture area, the stocking rate has increased in the state. In Santa Catarina, between 1975 and 2006, the stocking rate increased 50% and the animal unit density is the highest among the Brazilian regions (1.5 AU/ha) (EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA, 2014). The stocking rate average of our sample is still higher than the average for Santa Catarina state. For MIG farmers stocking rate was 3.63 AU/hectare, while for Non-MIG it was 3.14 AU/hectare[56]. Which means that the decrease of pasture area happened jointly with the intensification of this area, which can be explained by the application of more efficient dairy systems and also, perhaps, an increase in the purchase of animal feed. Data for subsequent years to the last Brazilian agricultural census (2006) show that milk production in Santa Catarina has increased 69% between 2007-2016 (EPAGRI/CEPA, 2018).

SOS MA (2013) also mapped SRL's land use, but in two categories: forest and others area for the year of 2013, see **figure 3.8**. Their results were different than what we found for 2014, one year later. They report a percentage of forest cover of 46%. This percentage of forest cover, between 20% and 60%, places Santa Rosa de Lima in one of the conditions to be considered a "source landscape", that is, areas which are not so small and fragmented that they do not justify an effort of recuperation, not so high that they do not demonstrate a need for recuperation. CUNHA and GUEDES (2013) used this methodological approach to help to identify priority areas for reforestation based on the biodiversity conservation goals for the Atlantic Forest. In this study, SRL was found to be located in an area that showed high importance for biological flow and very-high and medium-high priority for restoration. This is one additional indication of SRL's forest recovery needs.

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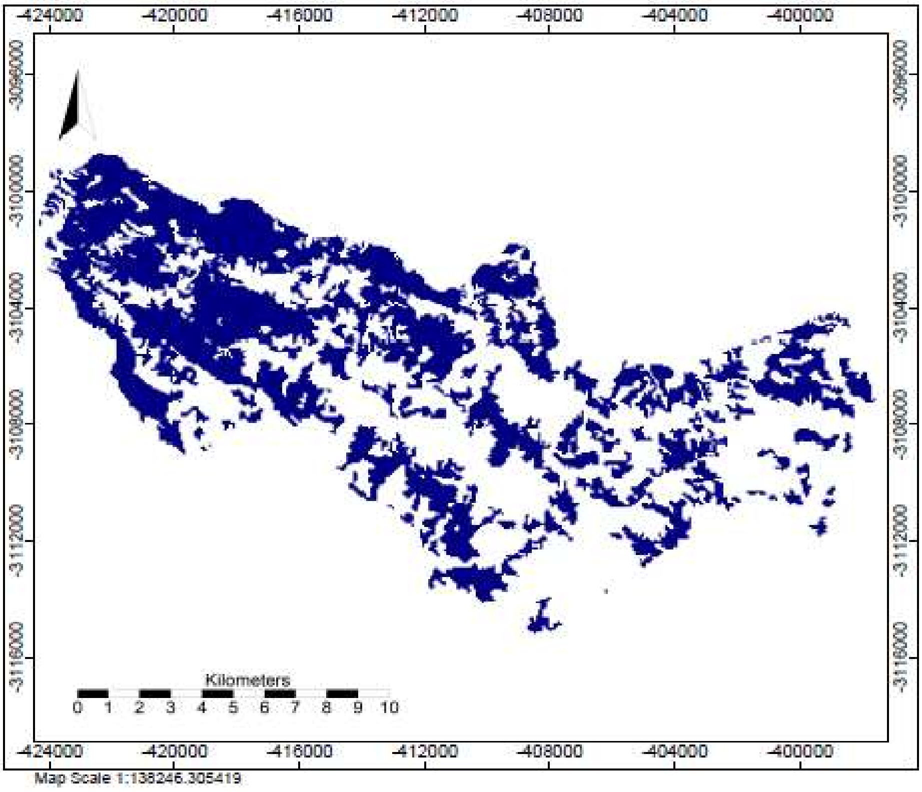
[55] Among 1985, 1996, and 2006, the pasture area decreased 1%, 26% and 7% respectively, in Santa Catarina state.
[56] 1 AU is equivalent to 450 kilograms. In this calculation we are only considering pasture area, we are not including area of crop for silage for animal feed.

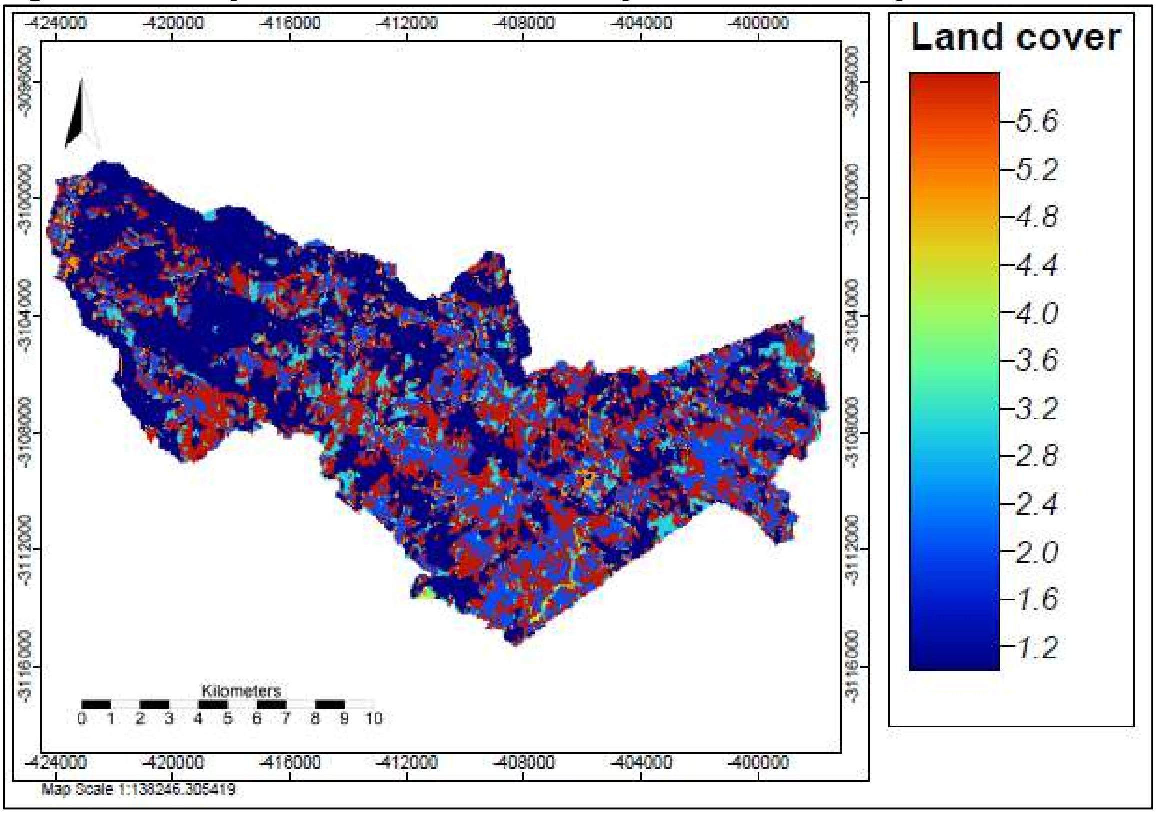
Figure 3.8 − Forest Cover Map of SRL according to SOSMA for 2013.



Source: SOSMA (2013)

On the differences between our map and SOS MA's map, we compared both (see **figure 3.9**). We both generally identified native forest and other land covers, represented by the two darkest blue colors in **figure 3.9**. However, about 39% of what we considered native forest, SOS MA considered as other. This difference is represented by the red color in **figure 3.9**. This difference maybe can be due to the difficulty in differentiating old planted forest and native forest. Since SOS MA did not map planted forest, we cannot better examine this hypothesis. The differences found between SOS MA's map and ours merit further examination and, perhaps, field verification.

Figure 3.9 – Comparison between our 2014 map and SOS MA's map.



Comparisons vary between 1 and 6, meaning: 1 – Forest in both maps; 2 – Others in both maps; 3 – Others in SOS MA map, planation forest in our map; 4 – Others in SOS MA map, water and others in our map; 5 – Forest in SOS MA map, water and urban area in our map; and 6 – Others in SOS MA map, native forest in our map.

Source: own elaborations.

As mentioned, for 2014, we found that about 18% of SRL territory is covered by planted forest. Many farmers maintain stands of pine and eucalyptus that they harvest as a cash crop (for construction, furniture production, charcoal, etc.). The stands of pine and eucalyptus are not native and are of limited value as habitat (POORE; FRIES, 1985); replacing them with a diverse stand of native species that can provide timber and non-timber forest-products and is a preferable ecological alternative. However, the Forest Code prohibits harvesting of native trees, except in cases where they have a management work plan approved by the environmental department of the state. Therefore, farmers are expected to avoid restoring areas in eucalyptus or pine to native vegetation, fearing that they will permanently lose the right to use this land for production. This creates a perverse incentive to maintain non-native vegetation even when viable alternatives exist.

For the year of 2014, we calculated the number, mean area (hectares) and mean euclidean nearest neighbor distance (meters)[57] of fragments for native forest and for planted forest, separately, and together (see **table 3.7**).

Table 3.7 − Number, mean area and distance of forest fragments

	Number of fragments	*Mean area (ha)*	*Mean euclidean nearest neighbor distance (m)*
Native forest	147	85.9	149.3
Planted forest area	701	5.1	188.6
Native and Planted Forest	602	33.5	260.4

Source: Own elaboration.

These numbers tell us how fragmented forest is and how isolated the fragments are. The importance of fragment isolation will depend on the species we are talking about. For example, *Eulaema nigrita,* a species of bee present in SC's Atlantic Forest, showed capacity of displacement of 440m in area of pasture (CROUZEILLES; LORINI; GRELLE, 2010); our result of mean distance between fragments of 149.3m is not enough to isolate it. However, for *Trogon surrucura*, a bird species also typical of Atlantic Forest, which showed a capacity of displacement of only 10m in a matrix of multiple types (idem), this distance could isolate the animal, and, based on the theory of metapopulation, bring it to its extinction (PERFECTO; VANDERMEER, 2008). Research in the Atlantic Forest shows that the probability of animals with intermediary sensibility to fragmentation, such as sub-forest birds and small mammals, to cross a distance of 50m is 50% (CUNHA; GUEDES, 2013). So, the distance of 149.3m can be considerable for these species.

PARDINI et al. 2010 argue that fragmentation, which is the degree to which a given amount of habitat is broken apart (VILLARD; METZGER, 2014), will have stronger effect on animal conservation if the fragment area is too small for the animal requirement, that is habitat loss. However, habitat configuration perhaps can mitigate to some extent the effects of habitat loss, through the maintenance of functional connectivity (VILLARD; METZGER, 2014). In view of this that matrix quality is very important.

[57] Euclidean nearest neighbor distance is a measure of patch context and has been used extensively to quantify patch isolation. Here, nearest neighbor distance is defined using simple Euclidean geometry as the shortest straight-line distance between the focal patch and its nearest neighbor of the same class (UMASS, 2017).

The mean area of native forest fragment in SRL for 2014 was about 86 ha, while for the total of forest (native and planted), it was 33.5 ha. The *Puma concolor*, a threatened feline species that has occurrence in Santa Catarina, has a requirement of area which vary between 3,100 ha to 24,300 ha in the winter, and 10,600 ha to 29,300 ha in the summer (CASTILHO, 2012). Therefore, if fragments of forest are not surrounded by a permeable matrix, even in the case of *Puma concolor,* which has been classified as a species of generalist habitat (SANTOS, 2014), those fragment sizes are considered too small, which can compromise the species existence in the region.

3.5 DISCUSSION

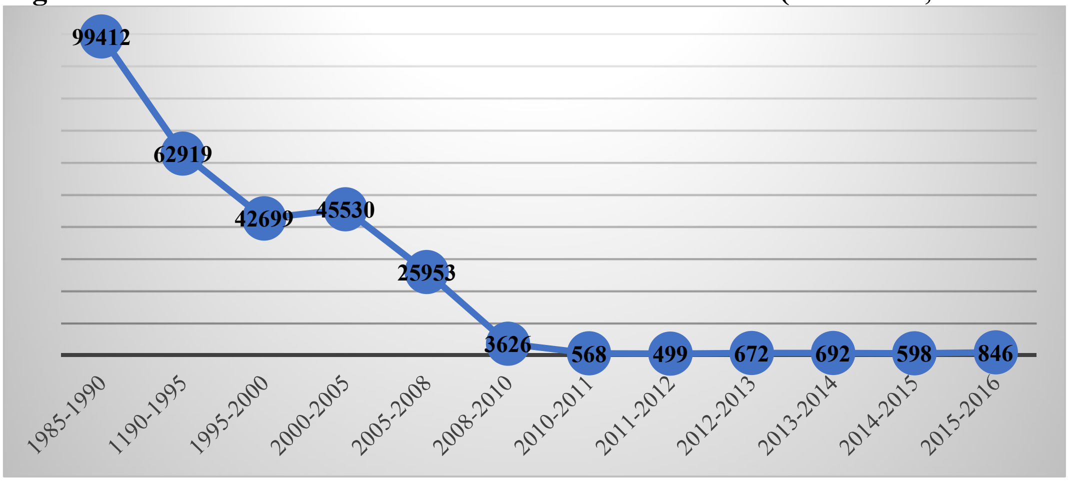
The analysis indicate that the MIG system brought some economic and environmental advantages when compared to the conventional system, which has been called Non-MIG. However, these advantages were less than the potential of the system suggests, and it is unclear if they indicate successful sustainable intensification. Firstly, the animal productivity and stocking rate were not statistically different between the MIG and Non-MIG farms. Secondly, the dependence on herbicide and purchased feed were higher for MIG Farmers. In order to be considered a sustainable intensification system, the adoption of MIG System in Santa Rosa de Lima needs improvements.

A problem faced for both systems is related to compliance with the forest code, which has been difficult due to the opportunity cost to retire land for recovery that has been in production use, as mentioned before. A possible alternative presented to solve it could be a payment for ecosystem services, since the majority of farmers, for any kind of system, showed to be willing to accept a payment that covers the opportunity cost by excluding this area from production. The efficiency of this alternative is unknown in the long-run, since the preservation is attached to a payment condition, rather than an environmentally responsible behavior. It also raises questions about justice and additionality; should farmers be compensated for restoring land they are legally obligated to protect? What about farms already in compliance? So, this proposal deserves a specific investigation to be safely considered an alternative solution, including ways to cost-effectively monitor ecosystem service provision.

The tendency of forest cover increase showed for Santa Rosa de Lima over the years has been partially in consonance with Santa Catarina State deforestation behavior (see **figure 4.8**). Between

1985 and 2012, the deforested area in the state substantially decreased. In recent years, between 2013 and 2016, the deforestation has subtly increased from 568 ha to 846 ha, which can be considered relatively constant if compared to the deforestation levels before 2010.

Figure 4.8 − Santa Catarina Atlantic Forest Deforestation (1985-2016, in hectares)



Data Source: SOSMA (2016)

Despite the success in decreasing the deforestation of the Atlantic Forest in SC, the state only retains 23% of its original forest area (SOS MA, 2017b). Authors have suggested that habitat configuration is particularly significant below a certain amount of habitat called the ‘fragmentation threshold’, usually around 10–30% (VILLARD; METZGER, 2014). This critical threshold represents the degree in which “structural connectivity decreases suddenly and, consequently, the requirements of a large number of species may no longer be satisfied, and extinction rates may increase rapidly” (METZGER; DÈCAMPS, 1997). Therefore, the current forest cover percentage of Santa Catarina state is critical for biodiversity conservation. It requires action to recover the forest habitat which makes Atlantic Forest one of the richest biome of the world (SOS MATA ATLÂNTICA, 2017).

In the Atlantic Forest, where most land is owned and managed by small family farmers, the transaction costs of conserving large tracts of land can be high, as multiple contiguous landholdings need to be acquired and restored. While the Brazilian Forest Code promotes conservation of native forest, compliance is measured at the farm scale, not the landscape scale. This results in a landscape that more closely resembles the matrix envisioned by proponents of land sharing. It remains unclear how effectively a patchwork of small stands of forest interspersed by crops and pasture will sustain biodiversity and protect ecosystem services. Furthermore, the composition of the cultivated land itself matters – islands of native forest in a sea of a single intensively produced crop is not the same as islands of native forest surrounded by a mosaic of agroecologically produced crops.

Connectivity among fragments is crucial for biodiversity conservation. Due to that, the matrix quality in which forest in embedded matters. As mentioned before, pasture is not a favorable matrix to the migration of some species. Agroecological practices and silvopastoral systems has the potential to improve the quality of pasture area for interpatch animals migration. “Surveys from all tropical areas indicate that silvopastoral systems offer great potential ecological services if managed properly” (DAGAN; NAIR, apud PERFECTO; VANDERMEER, 2008). Besides generating ecosystem services, silvopastoral systems are “a matrix that can maintain biodiversity and facilitate the movement of organisms between patches on natural habitat” (PERFECTO; VANDERMEER, 2008). So, silvopastoral system could be seen as an alternative for SRL’s dairy farmers.

For purposes of biodiversity conservation, the almost 18% of eucalyptus and pinus plantations in SRL are less problematic if compared with pasture matrix, since pinus crop areas are permeable matrix for some species (SANTOS, 2014). Additionally, if well managed, the undergrowth area of this crop can shelter high biodiversity of mammals, birds, amphibious and plants, due to the provision of favorable and similar conditions to the habitat for some species (idem). However, as mentioned by Cunha and Guedes (2013), other issues, besides biodiversity conservation, has to be taken into consideration when planned forest recover and protection, such as the provision of ecosystem services.

Eucalyptus and pinus are exotic species for Brazilian flora, due to that, it is already expected some impact to the ecosystem it is inserted. Eucalyptus and Pine consume much water and can cause significant reduction of the hydric resources of the watersheds in which they are planted. They compete vigorously with ground vegetation and with neighbored crops in situations where water is in short supply. Eucalypts are not good trees for erosion control, and the cropping of eucalyptus on short rotation, especially if the whole biomass is taken, leads to rapid depletion of the reserve of nutrients in the soil (POORE; FRIES, 1985; REPORTER BRAZIL, 2011). Vital (2007) strongly emphasizes that the negative impacts of eucalyptus plantation depends on the way it is managed, the biome it is inserted, the soil type, the rainfall density, and soil declivity. Therefore, for purposes of ecosystem health preservation, this issues need to be considered and farmers need to be assisted to better manage their eucalyptus and pinus crops, or been incentivized to change to a less environmental damaging economic activity, or, perhaps, to an activity that can works in favorable to the ecosystem it is part of.

3.6 FINAL CONSIDERATIONS

The debate on land sparing versus land sharing has motivates much research, but a question remains: is really necessary choose between one or another? It is already known that protected areas are not enough to guarantee biodiversity conservation if areas around the forest fragments are not permeable. Additionally, as mentioned by Perfecto and Vandermeer (2008), the current tropical landscape is characterized by natural habitats very fragmented and embedded in an agricultural landscape. This condition maybe demands land sparing and land sharing approaches simultaneously. The argument that friendly farming is less efficient than conventional agricultural systems, has been contested by many researchers (TSCHARNTKE et al., 2012; PERFECTO; VANDERMEER, 2008; 2010; BOURGEOIS, 2013). Therefore, systems that optimize the use of land, through the use of agroecological principles are desired and recommended. Sustainable intensification, or agroecological intensification as mentioned by Tscharntke et al. (2012), are alternatives, but mechanisms to ensure the recover and protection of land retired from agriculture need to be implemented.

In Santa Catarina state pasture area has decreased and milk production and animal density have increased, which can be associated to agricultural intensification practices. Though, more need to be done to conduct the dairy system to a sustainable intensification one. However, it is important to mention that, even in the SI approach, the goals of agricultural production has remained primarily productivist, with many important issues unaddressed, such as crops produced, post-harvest losses, the impacts of moving food to market, value-added production, or distributor/consumer waste, food efficiency for human nutrition, food security, food sovereignty, among other issues. These omissions are of some relevance to our case study of Santa Rosa de Lima, where most farmers have chosen to produce milk (an economic activity classified as one of the main activities that generates negative impact on environment) or tobacco (no nutritional value and considerable health risk), this last one for export, in some cases internationally. From a more holistic food systems perspective, these choices can be viewed as undesirable.

Changes are needed in the way that people produces food, but more than that. For the balance between food production, biodiversity conservation and ecosystem services provision, a change toward a more efficient human diet is needed; in the way human related to nature; in the drivers of food production; in the system of food stock and harvest to avoid waste; etc. Changes are necessary for all the agri-food system. For that, it is necessary the strong participation of one of the main actors of this process, the holders of the majority agricultural land, the small farmers. Researcher institutions and government play an important role in this process by sharing knowledge and facilitating food production systems that are more ecologically efficient.

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CHAPTER 4

SOCIAL-ECOLOGICAL TRANSFORMATION OF DAIRY SYSTEM AND POTENTIAL OF PAYMENT FOR ECOSYSTEM SERVICES AND PARTICIPATORY PROCESSES FOR CONTRIBUTION

4 SOCIAL-ECOLOGICAL TRANSFORMATION OF DAIRY SYSTEM AND POTENTIAL OF PAYMENT FOR ECOSYSTEM SERVICES AND PARTICIPATORY PROCESSES FOR CONTRIBUTION[58]

Abstract

The disruption of the dairy system, evidenced by the environmental degradation that it imposes, presents a need for social-ecological system transformation, a changing in the way human interact with the environment for food production. Even the process of transformation seems natural by the recognition of the necessity for change, the continuation of the process many times need to be planned, and constantly adjusted. Moore et al.(2014) developed a framework to analyze the process of social-ecological system transformation. In parallel, Gliessman (2016) describe levels for Food System Conversion Process. The combination of both approaches of analysis with the theory of triple-loop learning, as presented by Pahl-Wostl (2009), allowed the analysis of the social-ecological transformation of the Santa Rosa de Lima (SRL)'s Dairy System, in Brazil, which already has experienced a potentially agroecological practice (Management Intensive Grazing). By that, it was possible to verify in each phase the process of transformation is and identify some elements that are needed for its success. Among them, social learning stands out as indispensable, and financial capital is understood as an incentive to the process of transformation. To introduce both in the process, Participatory Processes (PPs) and Payment for Ecosystem Services (PES) are advocated as suitable tools, since PPs seeks to promote the conditions for social-learning, and the application of PES scheme is justified by the benefits that the adoption of agroecological practices provides. Therefore, the presents paper aims to analyze the social-ecological transformation of the dairy system in Santa Rosa de Lima based on this framework and the potential of PPs and PES in contributing for that process, based in the elements needed for that transformation and on the tools application.

Key words: Transformation. Agroecology. Payments for Ecosystem Services. Participatory Processes. Dairy System.

4.1 INTRODUCTION

The current agri-food system has followed the ideas proposed by the green-revolution[59], in which better levels of efficiency could be achieved by using synthetic fertilizers, pesticides, plant genetic

[58] This paper will be published with the contributions of Barbara Schröter, Juan P. Alvez, Claudia Sattler, Paulo Antonio de Almeida Sinisgalli, Abdon Schmidt, and Joshua Farley.
[59] The Green Revolution, occurred in the middle of the 20th century, was characterized by new crop varieties and livestock breeds, combined with increased use of agrochemicals and machinery, together with water control. The object was to increase food production from agricultural systems, in order to save people from starvation (PINGALI, 2012).

modification and mechanization (PINGALI, 2012). The inordinate use of these and the agricultural expansion have brought several environmental problems such as habitat loss, wasteful water consumption, soil erosion and degradation, pollution, genetic erosion, and climate change (WORLD WIDE FUND FOR NATURE, 2015).

Around 38% of earth's land area is under some agricultural use (FOOD AND AGRICULTURE ORGANIZATION, 2004) and within this context, livestock represents the single largest global anthropogenic land use, occupying between 25% to 45% (ASNER et al., 2004; HERRERO et al., 2009). Numerous studies have shown the social and environmental consequences of conventional livestock intensification on forests, biodiversity, soils, water and rural livelihoods (SCHERR AND YADAV, 1996; RUDEL, 1998; SZOTT et al., 2000; SANDERSON et al., 2002; STEINFELD et al., 2006; DALE AND POLASKY, 2007).

In Brazil, cattle ranching has been extensively referred as a major driver of deforestation and land-use change (NEPSTAD et al., 2006; MCALLISTER, 2008; GIBBS et al. 2010; COHN et al. 2011). Bustamante et al. (2012) evaluated that 75% of forest conversion in Brazil may be associated with this land use. Continuous or traditional grazing, widely practiced worldwide may produce overgrazing, a major cause of environmental impact, which can lead to above and below ground biodiversity and fertility loss, erosion, lower infiltration rates, higher nutrient runoff (Suttie *et al.*, 2005). Looking from a different perspective, the dairy sector is a major provider of rural livelihoods supporting over one billion people worldwide and generating almost $1.5 trillion annually (OTTE, et al., 2012; IFAD, 2004; STEINFELD et al., 2006; REID; SWIDERSKA, 2008), Therefore, achieving the balance between sound livestock practices, sustainable livelihoods, and environmental protection has major relevance.

The dairy activity impacts on ecosystem services[60] provision is an evidence of the system disruption, since the activity practices are destructing the natural conditions that it depends on, such as soil fertility, pollination, water quality, natural pest control. So, the continuity of the activity has been compromised on long-term. To restore ecosystems, produce food and improve rural livelihoods in the same land, farmers need to urgently switch their agricultural paradigm into an agroecological based model. Therefore, a social-ecological system transformation is needed.

[60] Ecosystems services are benefits provided to the society from healthy ecosystems (Costanza *et al.*, 1997; Daily et al. 2010). They are classified in four categories: provisioning, regulating, supporting and cultural (MEA, 2005).

Agroecological practices can potentially help bridge livelihoods and agro-ecosystems restoration. For example, the adoption of agroecological practices for pasture management has the potential to measurably produce and restore ecosystem services (CONANT et al., 2001; POTTS et al., 2009; ZAVALETA et al., 2010; JANZEN, 2011; TEAGUE et al., 2011). However, the transition from conventional to the adoption of agroecological practices has a cost and demands a time that sometimes the farmer may not be ready to undertake (SCHMITT et. al., 2013). Then, financial capital is needed to support this process.

Payment for Ecosystem Services (PES) have been frequently proposed as a useful tool in supporting environmental recovery, conservation and protection, even in cases that the activity by itself generates income. Examples are PES programs for encouraging agroforestry systems in Brazil and Costa Rica (MINISTÉRIO DO MEIO AMBIENTE, 2011; PAGIOLA, 2008). Therefore, an evaluation of this tool to meet some financial demands of the social-ecological transformation processes is needed and useful.

Social-learning is also advocate as essential for social-ecological system transformation process, since the success of this process will depend on the collective change of values and beliefs, through a wide collaboratively community participatory action involving, stakeholders, government agencies, academia and policy makers. In this context, participatory processes (PPs) deserves attention to be considered as potential tool to create the conditions needed for the promotion of social learning.

In Santa Rosa de Lima (SRL), a municipality located in the Santa Catarina Southern (Brazil), the introduction of Management Intensive Grazing (MIG) System by small farmers, supported by universities and government, to use land more efficiently, reduce pressure of dairy system on environment, create conditions for biodiversity conservation, generate ecosystem services, and support farmers livelihood, simultaneously, has showed evidences of a dairy system transformation process in direction to an agroecological system. However, in each phase this process of transformation is and what are the elements that can support it? Know the conditions of the transformation process and the elements needed for it can better help to understand the processes and conduct it on the desired way.

In order to answer the above question, the present paper has the objective of evaluating the socio-ecological transformation process of SRL's dairy system, identify some demands of the process, identify the elements that has potential to help this process of transformation, and how to introduce them. Based on what was previous mentioned, more attention is given to PPs and PES.

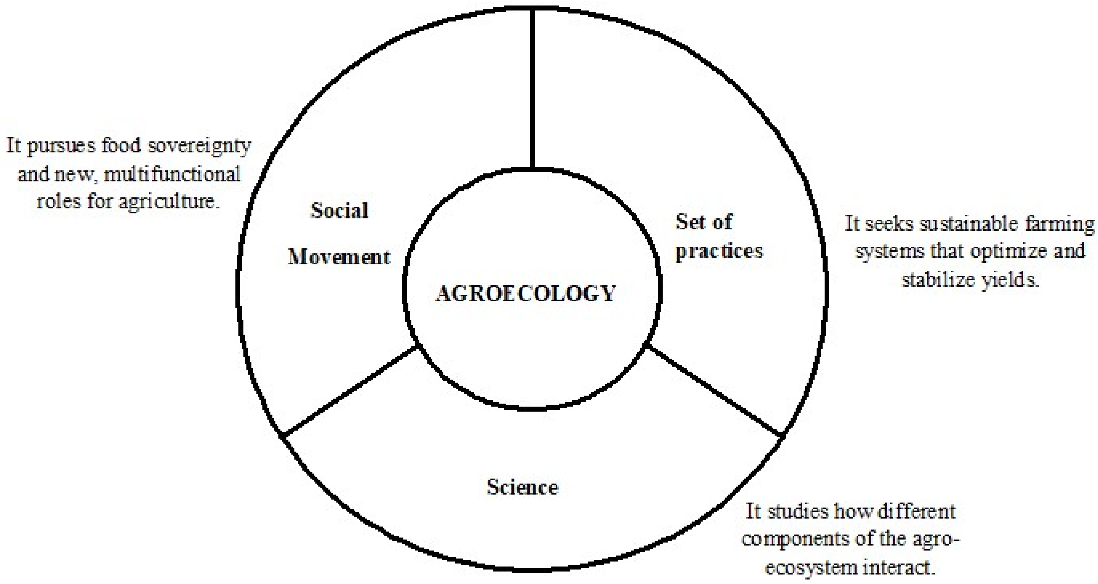
To reach the objectives, we apply, in combination, Moore et al (2014)'s analytical framework on socio-ecological system transformation, and Gliessman (2016)'s approach for food system conversion process. To enrich the analysis, and in view of the importance of learning process in system transformation, we add the triple-loop learning theory, as presented by Pahl-Wostl (2009), to those approaches.

We expect that this analysis can support the proponents of dairy system transformation process of Santa Rosa de Lima to understand the current stage of the transformation process and consider some elements to keep conducting it in the desired direction.

4.2 AGROECOLOGY AND THE TRANSITION PROCESS FROM CONVENTIONAL SYSTEMS

Silici (2014) defines agroecology as a scientific discipline, a set of practices and a social movement. This definition attributes to agroecology three different, but complementary functions that are summarized in the **figure 4.1**.

Figure 4.1. Agroecology: Science, Set of practices and Social Movement



Source: Own elaboration based on Silici (2014).

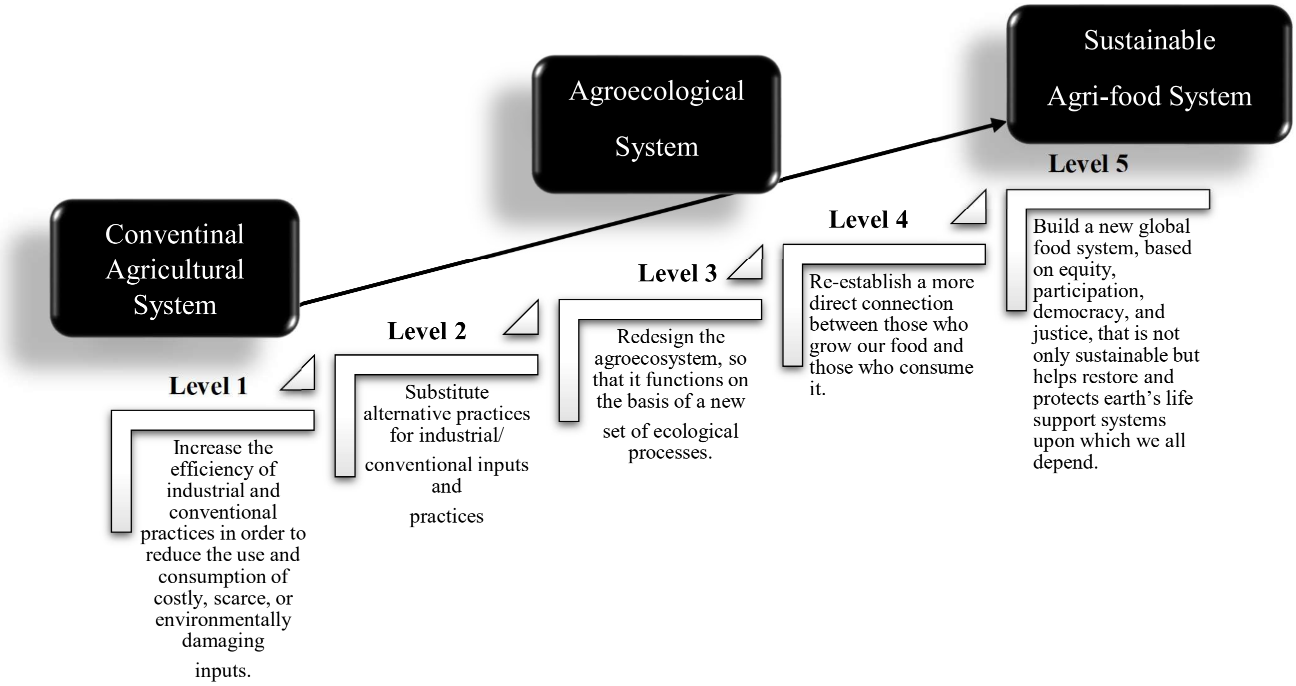
This definition of agroecology encompasses all the conceptual elements needed to move conventional agricultural systems in direction to agroecological systems capable to promote the social-ecological transformation of the current agri-food system. The empowerment of the techniques and scientific knowledge by farmers to promote the transition to agroecological systems is necessary, but not enough to generate the structural changes needed to create a sustainable agri-food system. Because of that, agroecology must be seen as a movement, in which the main concerns are with rural development, sustainability, equity, preservation of traditional knowledge, food security[61] and food sovereignty[62]. This requires a shift not only in agricultural practices, but in the relationship among actors of the agri-food system (producers, consumers, processors, distributors, wholesalers, retailers, etc) and between them and the food system's environment (biotic and abiotic elements of agroecosystems).

Gliessman (2004) defines agroecology as the application of ecological concepts and principles to the design and management of sustainable agroecosystems. However, his definition seems to be

[61] Food security depends not only on food availability at the right place at the right time, but also on access, utilization, and stability (Gliessman & Tittonell, 2015).
[62] Food sovereignty is at the very core of the re-making of local, regional, national, and even global food policy in order to move toward a true food democracy (Idem).

limited to the functions of science and a set of practices mentioned by Silici (2014), in his proposal of the steps for food system conversion process, from traditional to agroecological, Gliessman attributes to the agroecological approach the function of social movement too. The steps are summarized in the **figure 4.2**.

Figure 4.2 – Food System Conversion Process



Source: Own elaboration based on Gliessman (2016)

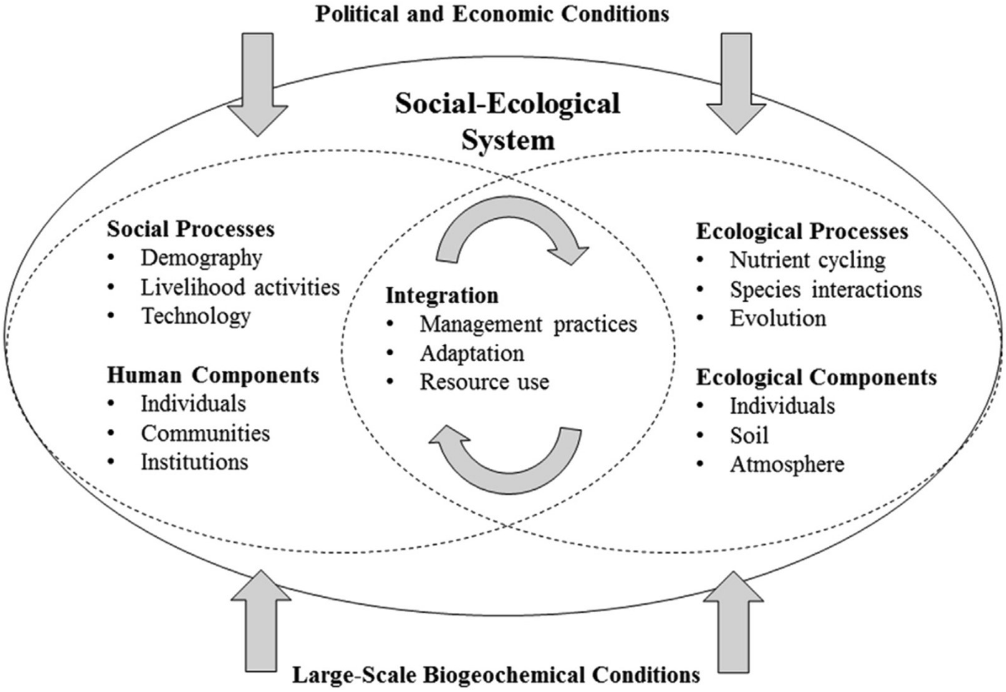
According to Gliessman (2004), the time needed to complete the conversion process until level 3 will depend on many factors such as the type of crop, the farm's ecological conditions and the history of management and input use. For short-term annual crops, the author estimates about three years to complete the level 3, while for perennial crops and animal systems, he estimates that farmers will need at least 5 years to achieve the level 3. The levels 4 and 5 were included in a more recent publication, (GLIESSMAN, 2016), and for them the author does not present any estimate on the amount of time needed to complete the overall process. But, since it encompasses the total food system, not only the farm individually, it probably will take much more time until reach the level 5 to complete the conversion process of the convention food system in a sustainable one. Here, we are referring to a social-ecological system transformation process.

4.3 SOCIAL-ECOLOGICAL SYSTEM TRANSFORMATION

Social-Ecological System approach frames "relationships between human and ecological components as part of a complex system with multi-scale feedbacks and dependencies" (VIRAPONGSE et. al., 2016, p. 84), see **figure 4.3**. Therefore, the social-ecological system encompasses social and ecological process and elements that are integrated through their interaction in an open environment (idem). If the conditions of these interactions are compromised, a process of adaptation is required. If the adaptation is reached, the system shows resilience[63] to these stresses. However, if the system does not adapt to the new conditions, it is shows loss of resilience and need of transformation (LYON, 2014).

[63] "Being resilient implied that basic functions of a regime are sustained despite of short-term disturbance or long-term societal or environmental changes (Pahl-Wostl, 2009, p. 354)".

Figure 4.3 −Depiction of an SES[64]



Source: Virapongse et al.(2016, p. 84)

The agri-food system, as a kind of social-ecological system, is compounded by social and ecological elements, which can be broken down into myriad smaller systems (CHASE; GRUBINGER, 2014). Defining agri-food system, Pimbert et al.(2001) mentions:

> "An agri-food system comprises the set of activities and relationships that interact to determine what and how much, by what method and for whom, food is produced, processed, distributed and consumed (Fine, 1998). Food systems include not just the production aspects of food and fiber, but also the preparation of agricultural inputs, processing, distribution, access, use, food recycling and waste." (p. 4).

The current social-ecological agri-food system has faced out extensive environmental, political, economic, and financial crises (GLIESSMAN, 2014). Additionally, its resilience has been shown to be low, and an adaptation process cannot be expected (LYON, 2014). The crisis of the system

[64] It is important to know the elements of a system and how they interact to be able to better anticipate how relationships and feedbacks within their system, intended or unintended, affect their achievement of management objectives (Virapongse et. al., 2016).

requires a transformation toward a more suitable social-ecological system based on social structural changes.

Moore et. al (2014) present a framework to analyze and plan[65] the transformation process of the social-ecological system (**table 4.1**). The authors combine three branches of social science literature on transformation change (social innovation[66], transition management[67], and social movements[68]) in order to enhance the Olsson et al.(2004)'s framework in defining the potential for social ecological system transformation. Olsson et al.(2004) attribute 3 phases for the transformation process (**Preparing for change**; **Navigating the transition**; and **Building resilience of the new trajectory of development**) and Moore et al. (2014) introduced one additional initial phase (**Triggers or Pretransformation**) and subprocesses.

Table 4.1 − Framework for analyzing the multiple subprocesses in each phase of a socio-ecological system transformation process and its relation to Gliessman's approach

Phases	*Subprocesses*	*Description*	*Overlap with Gliessman's approach (2016)*
Triggers or Pretransformation		Characterized by major social or ecological disruptions, which in turn, create windows of opportunity.	Level 1
Preparing for change	**Sensemaking**	Analysis of the structures that are most problematic for current trajectory.	Level 1
	Envisioning	Generating new innovations and visions for the future	Leve1and 2
	Gathering momentum	Self-organization around new ideas, networks of support are often created and mobilized, experimentation in protected "niches".	Level, 2, 3 and 4
Navigating the transition	**Selecting**	Choosing which innovation or change process in which to invest social, intellectual, and financial capital.	Level 3

It continues

[65] Even the proposal of the author is presenting a framework for analysis, it seems useful for planning the process of socio-ecological system transformation by showing the elements needed for it and the steps. As the author mentions, the transformation can be intentional and navigated (MOORE et. al, 2014).

[66] "Social innovation has studied more closely the different processes that may be driven by actors and networks within transformation, along with the types of power wielded, and the varying metrics that can be useful for demonstrating transformative impacts" (MOORE et. al, 2014, p. 2).

[67] "Transition management has established the critical role that active management of subprocesses, such as that of innovative 'niches', may play in shaping the path of transformation" (MOORE et. al, 2014, p. 2).

[68]Social movement theory "have brought light to bear on the contested nature of any social-ecological transformation" (MOORE et. al, 2014, p. 2).

Continuation

Phases	Subprocesses	Description	Overlap with Gliessman's approach (2016)
	Learning	Evaluating the results of earlier experiments and developing shared understandings or new forms of knowledge.	Level 3 and 5
	Adoption	Widespread uptake or replication of innovative change that was successful in experimental stage, tipping point.	Level 2 and 3
Institutionalizing the new trajectory	**Routinization**	Managing dynamic stability to embed new trajectory and establish or strengthen new feedbacks.	Level 3
	Strengthening cross-scale relationship	Involves scaling up the change, which often involves a different type of innovation than was created originally in niche (needs to suit different contexts).	Level 3 and 4
	Stabilization	Transformed system reaches new "attractor" but active resistance from powerful actors at different scales is likely, and actors need to deal with next, unanticipated perturbations.	Level 4 and 5

This framework, however is not mentioned by Gliessman (2016), has much in common to his proposal for a food system conversion process (**figure 4.2**). Overlapping both approaches, it is possible to locate the different levels of the agrifood system transformation of Gliessman approach in the phases' subprocesses of the Moore et al.(2014) framework for socio-ecological system transformation **(table 4.1).**

According to the authors, this framework implicitly shows what can be expected to change and how the process underpinning that change will unfold in a social ecological transformation. It can be clarified by the condition that the ecological and social elements are linked, but they are not homologous. In other words, the change in an ecological element will not necessarily generate the change in a social element necessary to direct the social ecological system into a transformation process. Therefore, this framework also brings attention to the importance of identifying the key ecological elements that are expected to change due to alterations in key social elements that can generate social transformation. The key social elements are norms, values, and beliefs; rules and practices, such as laws, procedures, and customs; and the distribution and flow of power, authority, and resources. The ecological key elements are natural capital and ecosystem services (BRAND, 2009; BIGGS et al., 2012; WESTLEY; ANTADZE, 2012; apud MOORE et. al., 2014).

Menzel and Buchecker (2013) refer to participatory planning as a key element in the social-ecological system transformation. According to them, some of the outcomes of the participatory planning process are social learning, trust, social capital and political capital. Among them we will emphasize social learning since it can induce cognitive changes that are extremely needed for most phases of the social ecological transformation process, most specifically for the **Learning** and **Adaptation** subprocess of the **Navigating the transition phase**. According to Muro and Jeffrey (2008, p. 339), "the transformation into a sustainable society must be collectively elaborated and learned".

Another needed element is financial capital that it is required to support research, sharing of knowledge, implementation of new techniques, and social mobilization and organization, which are present in all of the social-ecological system transformation process phases. Even social leaning is costly (MURO; JEFFREY, 2008). In order to address financial issue needed for the process of transformation, we consider the Payment for Ecosystem Services (PES) as a potential tool. Both, PES and Participatory Processes (PPs) are presented in detail in the next sections.

4.4 PAYMENTS FOR ECOSYSTEM SERVICES

Wunder (2005) defines payments for ecosystem services as a voluntary transaction where a well-defined ecosystem service is bought by a minimum one buyer from a minimum one service provider if and only if the provider secures its provision. This definition has received many criticisms due to: a) the voluntary character of the payment, which sometimes is not possible; b) the complexity to well-define the provision of an ecosystem service; c) the conditionality of the payment, which requires measurement of the service provision (monitoring that creates high transaction costs[69]), clear evidence of a causal relation between the seller action and the ecosystem service provision, and the legal tenure of the land; and d) this definition ignores the necessity of an intermediary agent to manage the contract between sellers and buyers that in many cases is

[69] Vatn (2010) defends that the Wunder's definition is more like a theoretical reference point and that the author, however does not mention transaction costs, is not unaware of these issues, since he uses much space on discussing them in various papers.

required (VATN, 2010; MURADIAN, et al.2010; BRASILEIRO, 2013; FARLEY; COSTANZA, 2010).

Vatn (2010) and Muradian et al.(2010) additionally critic Wunder's definition, since it is based on a perfect market. According to the authors, in rare cases the payments for ecosystem services happens inside of a perfect market as designed in the Coasean theory on market solution to the problem of externalities[70].

By analyzing many cases of PES and the complexities embedded in its application, Muradian et al.(2010, p. 1205) propose a different definition for Payments for Environmental Services[71], referring to that as a "transfer of resources between social actors, which aims to create incentives to align individual and/or collective land use decisions with the social interest in the management of natural resources". According to the authors this payment can be monetary or non-monetary, and these transfers are designed according to social relations, values and perceptions. This definition comes from the recognition that: a) in rare cases ecosystem services are traded in a pure and perfect market; b) the monetary payment in some cases is not the main condition to bring voluntaries to take part in a PES scheme; c) social values plays an important role in the PES design and outcomes.

Muradian et al. (2010) emphasizes that PES can be integrated within existing regimes of rural development. They argue that PES must aim more than efficiency of natural recourses use, but has also to object poverty alleviation. Therefore, efficiency and equity has both to be considered when designing PES.

[70] In the case of environmental problems, the Coasen theory proposes that, as long as transaction costs are low enough and property rights are clearly defined, individuals would trade their rights to achieve the optimum point of efficiency in the use and provision of environmental services. "The creation of markets for trading environmental services thus becomes the solution for market failures leading to undersupply of this type of services" (MURADIAN et. al, 2010, p. 1203).

[71] Although, the term Environmental Services and Ecosystem Service have been very often used interchangeably in the literature (NUSDEO, 2012), MURADIAN et al (2010) prefer to use the term Payments for Environmental Services rather than Payments for Ecosystem Services. They argue that environmental services also comprise benefits associated with different types of actively managed ecosystems, such as sustainable agricultural practices and rural landscapes.

4.4.1 Limitations of Payments for Ecosystem Services

Besides the difficulties to stablish a PES scheme inside of Wunder's definition requirements, mentioned in the previous section, Vatn (2010) brings attention to the reverse and harmful effect that the adoption of a PES scheme can generate when the monetary payments was not the main motivation for environmental services preservation previously. "Including payments in a situation where the service is not seen as an economic good may just create hostility and deep conflict" (VATN, 2010. p. 1248). The author states this by analyzing many cases of people's willingness to collaborate in some collective decisions through compensation by monetary payment. The idea of paying for a good behavior can make the beneficiary of the payment thinks that in case of no payment s/he has the right and social acceptance to misbehave, and "payments may then change the logic from doing what is considered appropriate to start thinking in instrumental terms, calculating what is individually best to do" (VATN, 2010. p. 1250).

Additionally, in the case that farmers do not have the legal title of the land and there is not additional area to farmers' basic needs to offer for PES, the opportunity of these farmers to take part in a PES scheme is limited, therefore, "there is a danger that PES may reinforce existing inequalities" (VATN, 2010. p. 1248). The reinforcement of existing inequalities is also true seen from the side of the buyer that pays to access some excludable environmental goods[72]. Since prices may increase to reduce the demand of environmental goods, the poor may not be able to pay, while for the rich the price is not a matter (VATN, 2010).

The limitations of PES are also associated to its transaction costs, which are one of the biggest obstacles to stablish a PES scheme. These costs include making a diagnosis of the potential environmental services provision, designing and implementing the PES scheme, which includes creating mechanisms for trade, involving many agents, managing seller and buyers' relationship, monitoring contract compliance by both sides, etc (VATN, 2010, MUDARIAN et. al, 2010; WUNDER, 2005; PERU, 2010).

In order to reduce the transaction costs, Vatn (2010) suggest the intermediaries can works on social values, perception and knowledge. In PES schemes the intermediaries (state, firms, and NGOs) have been the dominant agent by defining the good, establishing the group of 'sellers' and 'buyers'

[72] An excludable goods are goods that are subjected to property right, so its use can be blocked by the legal owner (Daly & Farley, 2010).

and setting a predefined price (idem). They function like this in order to create the market conditions for a PES scheme. However, as has been mentioned, PES not necessarily happens inside of a market structure, but also inside of other governance structures like community management, which is a governance system based on cooperation (idem). So, the intermediaries can also act to create the social conditions to engage the community in natural resources management by influencing values and perception through transference of knowledge (SCHRÖTER, et al.2015).

In addition to the determination of an intermediary, another aspect that is needed to be fomented is the trust between sellers and buyers of ecosystem services. In receiving an incentive to invest in a transition to an agroecological diary system, for example, farmers need to trust that this new system will generate higher economic, social and environmental gains than the conventional one, and they also need to trust that the payment will be effectively done to engender their full participation. On other hand, the buyers of the ecosystem service need to trust that the transition to an agroecological dairy system they are funding will generate the expected ecosystem services and that the farmers will comply with the conditions of land management for the payment. Additionally, due to the high cost and complexity to define measures of ecosystem services provision, the conditionality of the payment depends on a contract of trust between the two sides. Trust seems to be a key factor in a PES scheme in a governance structure of community management.

The identification of the PES limitations suggests that the payment by itself will not promote the changes in the land management which is needed to guarantee ecosystem service provision in the long-term. That occurs, because PES does not promote needed structural changings of the agri-food system, such as the way that humans interact with the environment. Therefore, the success of a PES scheme strongly depends on state and community engagement (MURADIAN et. al, 2010). For a solid community engagement, it is needed more than the market structure can offer, it is needed the empowerment[73] of the stakeholders with regards to social and environmental responsibility, which, in turn, can be promoted through a social learning in participatory processes.

[73] Adaptive governance, which strongly relies on participatory approaches, “is most successful in contexts where considerable work has been done to empower stakeholders, and the stakeholders themselves seek to create change and transformation in their community” (Virapongse, 2016, p.88).

4.5 SOCIAL LEARNING IN RESOURCE MANAGEMENT

Social learning can be defined as a process of social change in which the communication and interaction of different actors are required in a participatory setting to promote social outcomes (generation of new knowledge, acquisition of technical and social skills, development of trust, etc) to form the basis for a common understanding, agreement and collective action (MURO; JEFFREY, 2008).

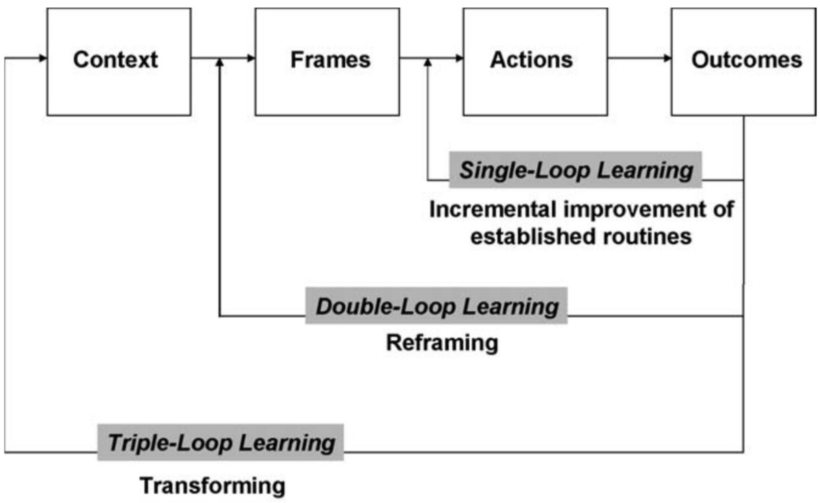
Muro and Jeffrey (MURO; JEFFREY 2012; MURO; JEFFREY 2008) present a good overview over the concept and its historical development, especially focused on social learning in resource management and participatory processes[74]. In this context, social learning is mainly based on three different theories (MURO; JEFFREY 2008), citing van der Venn (2000): 1) communicative learning - a person constructs an inter-subjective understanding of a situation with others (PAHL-WOSTL; HARE 2004; KING; JIGGINS 2002; LEEUWIS; PYBURN 2002; RÖLING; MAARLEVELD 2002, RÖLING 2002); 2) transformative learning - people gradually change their views on the world and themselves (ARGYRIS; SCHÖN 1978, PAHL-WOSTL 2002); and 3) experimental learning - concrete experiences lead to reflection and, in a second step, to abstract conceptualizations, which then have to be tested in practice (Kolb 1984).

Based on the transformative learning theory, Pahl-Wostl (2002) presents an important approach based on the assumption of feedback loops (See **Figure 4.4)**. Pahl-Wostl and Hare (2004) define social learning as "an iterative and ongoing process that comprises several loops and enhances the flexibility of the social-ecological system and its ability to respond to change" (PAHL-WOSTL; HARE, p.195, 2004). As a process, it encompasses three levels: single, double and triple-loop learning. Single-loop learning refers to an incremental of action without questioning the underlying

[74] Reed et al.(2010) criticize the so far existing work on social learning in environmental management. According to him, the weaknesses of the concept poses on the fact that it cannot be assumed automatically that conditions and methods necessary to facilitate social learning are given. Besides, the concept itself and its possible outcomes sometimes are confused. Social learning can be a process or an outcome. If looking at the outcome then it must be considered that a range of alternative processes may lead to the same outcome of social learning. Also, it is not clear if participatory processes are a requisition or a consequence of social learning. Further, little distinction between individual and wider social learning is made. Individual learning occurs often through social interaction or facilitative mechanism like dissemination of information. It is not clear, if a broader social group will learn from certain activities, nor, if people necessarily change their behavior as a consequence of learning. Finally, the concept sees shared understanding and consensus as main driver for progress rather than conflict and competition.

assumption” (PAHL-WOSTL, 2009, p. 359). Performance of the existing system is improved, within the traditional routines, but taking into consideration collective decision-making. Double-loop learning supplementary is reflecting on actions and assumptions within a value-normative framework. Actors reframe their problems and goals and experiment with new approaches. Finally, triple-loop learning means reconsidering underlying values and beliefs, world views, therefore promoting a transformation of the structural context and factors that determine the frame of reference (ARGYRIS; SCHÖN 1978; FAZEY; FAZEY; FAZEY 2005; KEEN; BROWN; DYBALL, 2005; TOSEY; VISSER; SAUNDERS, 2012).

Figure 4.4 − Sequence of learning cycles in the concept of triple-loop learning



Source: Pahl-Wostl (2009).

On transformation, Moore et al. (2014) defines it as a “form of change that is more significant than adaptation, one that recombines existing elements of a system in fundamentally novel ways”. For Muro & Jeffrey (2008, p. 330), “transformation often occurs in response to an external trigger, when faced with a disorienting dilemma”, which cannot be explained by the current knowledge. This leads to critical reflection and consequently transformation. To finalize, the authors emphasize that social learning not only remains in the cognitive realm but that it will lead to collective action.

4.5.1 Social Learning through Participatory Processes

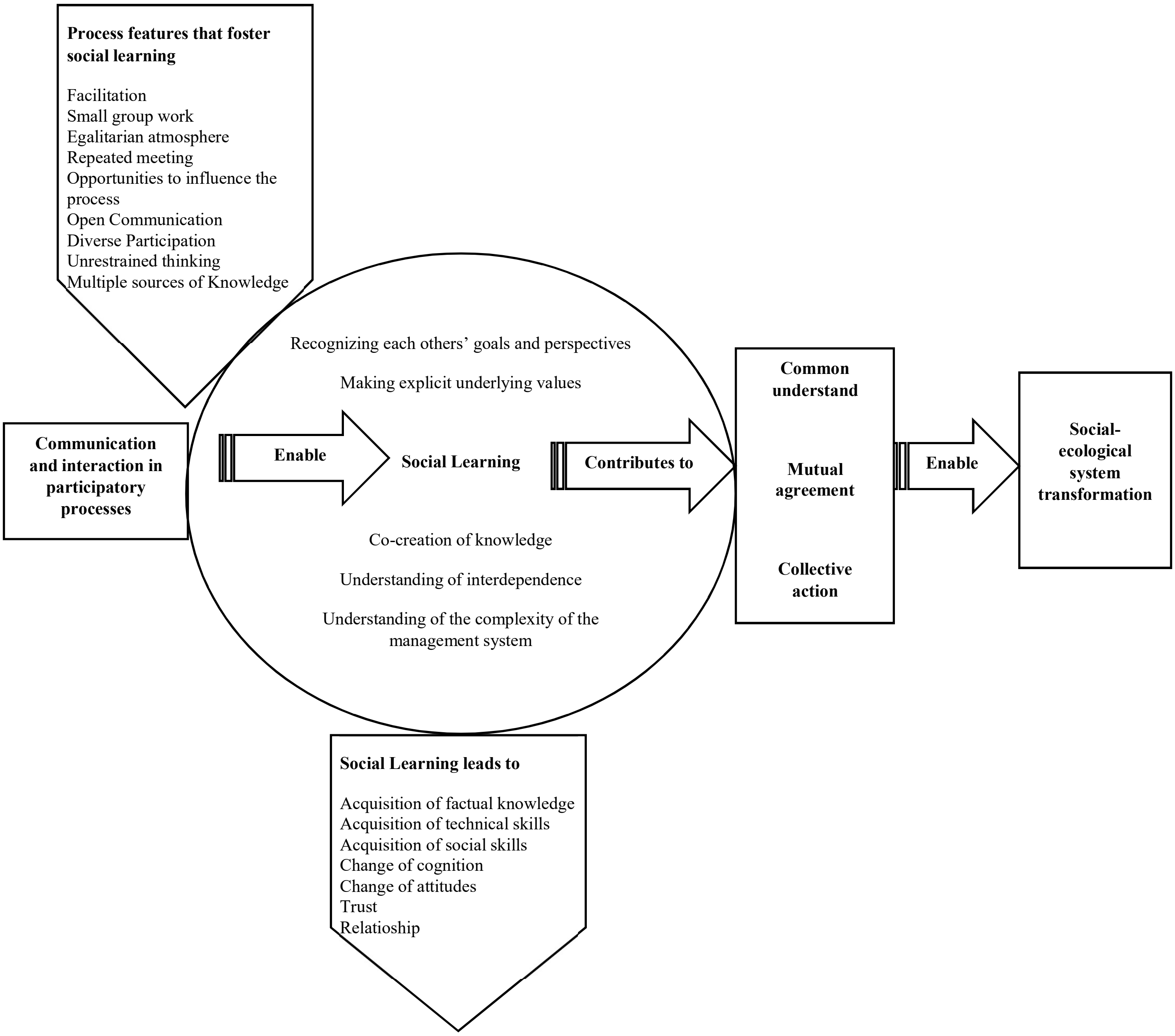
The initial process of social learning seems kind natural, since the disruption of a system requires urgently new actions to maintain its operation. However, the ongoing process of social learning that promotes structural change demands social engagement and transfer of knowledge. Muro & Jeffrey (2008) mention that for the process of learning it is needed the establishment of "participatory learning environments and platforms, where individuals can meet, interact, learn collaboratively and take collective decision". Therefore, participatory processes have been presented as the adequate tool. Communication and interaction in participatory processes enable social learning which contributes to common understanding, mutual agreement and collective action (MURO; JEFFREY, 2008).

By Participatory Processes (PPs), we refer to an approach that aims to assemble a diversity of actors to research, reflect, plan and act for collective interests to promote social transformation. Very close to Méndez et al. definition (2015) of Participatory Action Research (PAR), the concept presented for PPs concept includes, besides the own PAR, participatory research, participatory planning and participatory management. Kindon, et al. (2009) defines PAR as a collaborative process of research, education and action explicitly oriented towards social transformation. Participation in this sense refers to more than engagement in a specific activity, but refers to being active in the practices of social communities and in constructing communities' identities. "This understanding of participation implies that it shapes not only what we do, but also who we are and how we interpret what we do" (MURO; JEFFREY, 2008). Bulkeley and Mol (2003, p.149) mention that "participation and deliberation are seen as a process which can create different forms of rationality and civic virtue, which together can form the basis for better environmental decisions''. Since it is not limited only to research and action, it was considered more appropriate mention it as Participatory Processes (PPs).

The PPs methods are in general applied by conducting meetings, workshops, and speeches with the community. The activities are planned to create conditions for dialogue and reflection of participants about the agenda topic and subsequently collective action. For example, for the use of chemicals on agriculture, the public sector, or scientist community, invite local rural community, farmers, and other actors of the regional agri-food system to discuss how to solve the problems related to the use of these chemicals. To abandon permanently the use of chemicals, farmers will need more than a simple conversation and/or economic incentive. They will need to suffer a cognitive change on their relationship with the environment. This cognitive change of values and beliefs is the result of a triple-loop learning, mentioned before, and can be achieved by conducting a long and deep research on the problem to understand it in detail. For that, it is necessary to listen to actors that has something to lose or gain with that. Pahl-Wostl and Hare (2004) mention as key ingredients for social learning in resource management the following capacities being created amongst actors: awareness of each other´s sometimes different goals and perspectives; shared problem identification; understanding of the actors´ interdependence; understanding of the complexity of the management system; learning to work together; trust and the creation of informal as well as formal relationships.

In the **figure 4.5,** Muro and Jeffrey (2008) presents a compounded model of social learning drawn from the literature. Participatory processes are showed as a mean to enable and encourage social learning. As it can be seen, PPs can be used as a tool to promote social learning process that is indispensable to social-ecological system transformation.

Figure 4.5 −A compounded model of social learning drawn from the literature



Source: Own elaboration based on Moore et al.(2008).[75]

[75] Social-ecological system transformation was included by the authors.

4.6 METHODOLOGY

4.6.1 Study Site

Santa Rosa de Lima (SRL) is a small municipality located in the Santa Catarina Southern, in Brazil. The city is home of 2,065 people. 75% of its population lives in rural area, and the majority of them works with dairy activities (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATISTICA, 2010; 2006). Management Intensive Grazing (MIG) System has been applied in the region to sum to other agroecological initiatives in the municipality that gave to the city the title of Agroecological Capital of Santa Catarina.

4.6.2 Data collection

Besides bibliographic research, we used data on farmers perception and their economic activity performance. These data were collected, through interview and an accounting project, to allow the analysis of the SRL's dairy system transformation. The interview was conducted in Santa Rosa de Lima with 41 Dairy Farmers, 21 farmers adopting MIG (MIG Farmers), and 20 farmers do not adopting MIG system (Non-MIG farmers), during April and May of 2013. The accounting project collected monthly, during one year (August/2013-July/2014), information of the dairy activity of 27 farmers (15 MIG and 12 Non-MIG). To analyze the differences between farm characteristics of the two groups (MIG and Non-MIG Farmers), we used t-tests (T) for data that were normally distributed and the Mann–Whitney U test (U) for data that were identified as nonparametric. To test the normality of distributions, we applied the Kolmogorov-Smirnov test. Analyses were conducted using IBM Statistical Package for Social Sciences (SPSS) Version 24.

4.6.3 Framework of Analysis

We use Moore et al.(2014) framework to identify the current transformation status of the Santa Rosa de Lima's dairy system and the elements needed to move the present system to the social-ecological system transformation required to make it sustainable. Moore et al. (2014) framework is more general, being adequate to be applied for any system type. Therefore, this framework was combined to the Gliessman's approaches on food system transformation, which is more specific for agri-food systems, to help to identify in which level of this process of transformation SRL's dairy system is located. To enrich the analysis, we applied the triple-loop learning approach (PAHL-WOSTL, 2009) to identify in which level of learning SRL's dairy farmers has already reached and in which level they need to achieve to be able to promote the social-ecological transformation of the dairy system in the municipality. These theories, however are different, are complementary and all refer to the transformation of social-ecological systems. The combination of these theories was necessary, since individually they were insufficient to answer our research question. **Figure 4.6** presents the combination of these theories to analyze the socio-ecological system transformation process of Santa Rosa de Lima's dairy system.

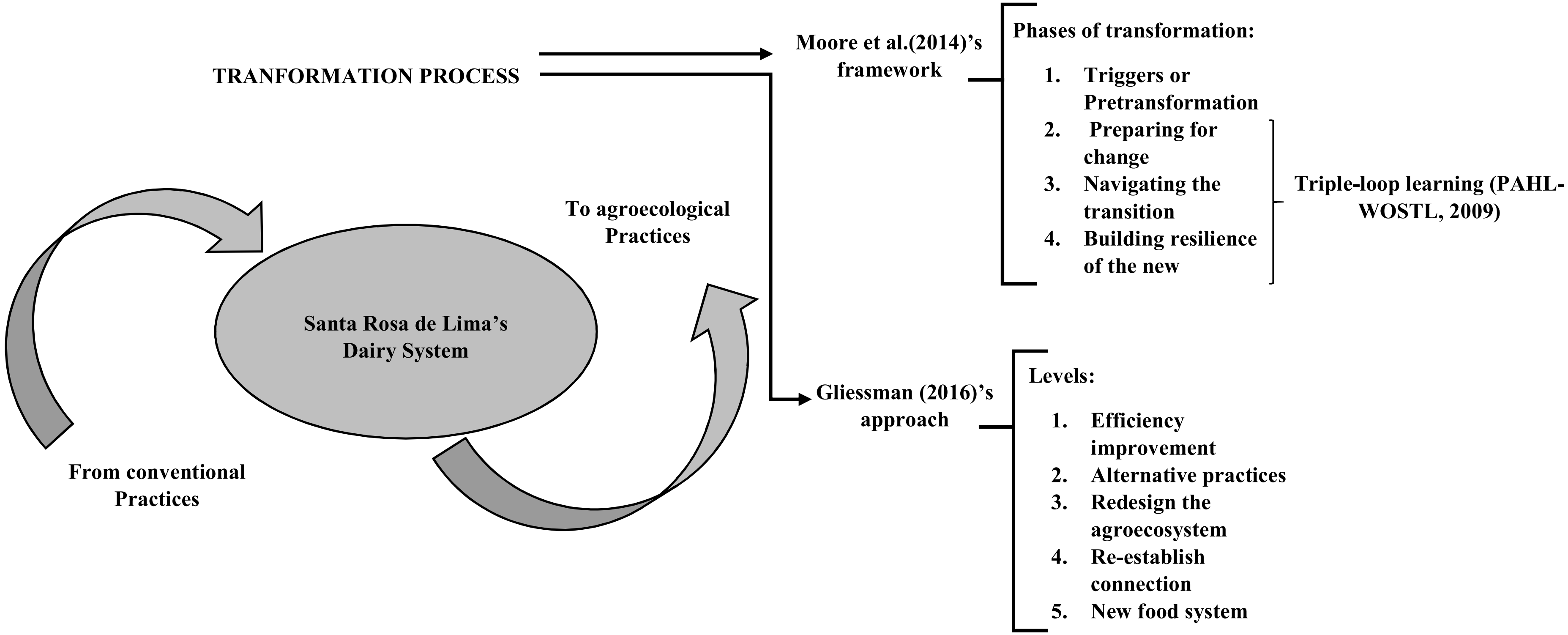


Figure 4.6. Methodological framework

4.7 RESULTS AND DISCUSSION

4.7.1 Social Ecological System Transformation of Santa Rosa de Lima Dairy System

Applying Moore et al.'s framework, Gliessman's approach and the theory of triple-loop learning (PAHL-WOSTL, 2009) to analyze the status of the social-ecological system transformation of SRL's dairy system and the elements needed to contribute for this process, it was found the following for each phase:

4.7.1.1 Phase 1. Triggers or Pretransformation /Level 1 of Gliessman: concluded

Moore et al.(2014) emphasizes that the decline of ecosystem services can lead to a sudden reevaluation of existing frameworks and management practices. The conventional practices applied for dairy activity has been seen as unsuitable since the provision of ecosystem services, which the agriculture activities and human life is depended on, has been compromised by the activity, as mentioned in the introduction. So, the start point of the dairy system transformation in SRL, which had also been applying conventional practices, was triggered by the globally known ecological perturbations resulted from the direct and indirect impact of the activity on the environment, such as climate change, erosion, loss soil biodiversity, landslides, and water and soil contamination (SOS MA, 2017; WORLD WIDE FUND FOR NATURE, 2015, NEPSTAD et al., 2006; MCALLISTER, 2008; GIBBs et al. 2010; COHN et al. 2011; BUSTAMANTE et al., 2012; SUTTIE et al., 2005). Tobacco farming preceded dairy activity in the municipality. It was replacement by dairy activity and organic production due to the impacts on environment and human health that this activity generated. Though these resultant perturbations could be expected, their creation was not intentional. They were neglected until the agriculture and human conditions started to be compromised. This context opened opportunity for change, and, thenceforth, a deliberate transformation process begun, since the current social-ecological conditions became undesirable.

Taking the opportunity for change in SRL, the management intensive grazing (MIG) was presented as the sustainable alternative to the conventional dairy system due to its high potential to be agroecological (ALVEZ et al.; 2014), which has been in development in the region since the late 1990s. This approach is also known as the Voisin Rational Grazing System (VRG) due to its proponent André Voisin (MELADO, 2003).

According to Voisin, 1988; Rust et al., 1995; Pinheiro Machado, 2004b; Briske et al., 2008; Murphy, 2008; Teague et al., 2011; Alvez, 2012, MIG rationally rotates high stocking density cattle throughout subdivided paddocks, preferably with the same size and shape, every 12 (or up to 72 hours), using lightweight electric fencing. In MIG, animals graze only when the forage is at its optimal rest stage, achieving maximum grazing efficiency, to provide the herd's nutritional needs, and converting forage pastures into milk to provide the herd's nutritional needs, in a steady pattern of growth-grazing-regrowth. Forages then have enough time to re-grow before they are grazed again. Once the area has been grazed to a certain height, sufficient time is needed for the animals to return to the same paddock.

Voisin (1988) proposed the optimal rest period, summarized by his four universal “Laws” of rational grazing. These principles consider forages and animals and are valid within any climate, soil type or region. That may occur with very small plots, depending on the rate of growth during that period and the number of animals in relation to the area. The idea is to stock the space densely enough that the animals eat graze everything more or less evenly.

4.7.1.2 Phase 2. Preparing for change: partially concluded

Sensemaking /Level 1 of Gliessman: This subprocess is characterized by the understanding of the current situation, by analyzing what elements of the SES make the system’s current trajectory most problematic (MOORE, et. al 2014). The authors consider collective and individuals actors to prepare the system for change. In SRL’s case, Federal University of Santa Catarina (UFSC), a public institution, was the actor that started this process. They have conducted many studies (SCHMITT, 2002; ALVEZ, 2012; FARLEY, et. al, 2012) to understand the conventional dairy system elements responsible to make the system vulnerable and problematic, such as: high use of chemicals - which besides being intensive in fossil fuels (a scarce resource), is toxic to human and animal life -, low animal stocking rate, deforestation, overgrazing, and low pasture quality.

The questioning of if we are doing things right represents a step on the single-loop learning (FLOOD; ROMM, apud PAHL-WOSTL, 2009). So, in SRL’s case, considering to apply damaging techniques and seek for alternatives show achievement of single-loop learning in the social-ecological system transformation.

Envisioning /Level 1 and 2 of Gliessman: This subprocess includes the analysis of the alternative practices. Research conducted on MIG system have showed that its adoption provides better higher yields of pasture, better stocking rate, increase of density and quality of forage swards, reduce erosion, promote nutrient cycling and decrease nutrient runoff into water bodies, thereby enhancing water quality in nearby waterways (VOISIN, 1988; MELADO, 2003; PINHEIRO MACHADO, 2004a; MURPHY, 2008; ALVEZ et al., 2014, DE RAMUS et al., 2003, ROTZ et al. 2009). MIG can also increase and influence biodiversity (MELADO, 2007; O'CONNOR et al., 2010) and promote greater storage of carbon in soils (TEAGUE et al., 2016, DE RAMUS et al., 2003).

Another key regulating service of agroecological relates to hydrological processes. MIG can benefit water receiving streams and water bodies because it keeps soils well-covered, preventing erosion and nutrient run-off (SCHMITT et al., 2013). Additionally, the soil type, texture, structure, biota and organic matter positively influence the water infiltration rate under MIG systems (MELADO, 2007).

MIG relies on well-managed pastures and can potentially restore ecosystems services, increasing food production and quality, and enhancing rural livelihoods (SCHMITT et al., 2013).

Besides the environmental advantages in adopting MIG, many authors mention the economic advantages in adopting this system. Some of the economic outcomes reported for MIG, when compared with other systems, include lower operating costs, reduction of labor requirements, reduction of animal health problems, reduction of expenses attributed to crop production, and risks related to the reliance on out-farm inputs, resulting in higher net returns per unit of milk produced or per cow (PARKER, et al. 1992; HANSON et. al., 2013; TAUER; MISHRA, 2006; GILLESPIE, et. al., 2009; WINSTEN, 2000).

Due to the environmental and economic advantages already presented in the researches mentioned, that MIG was seen as an alternative practice to the conventional ones in SRL.

The accounting and economic study we conducted in Santa Rosa de Lima showed that the dairy farmers that adopt MIG System presented better economic performance for some profitability variables of Net Income (profit), Return on Assets (ROA) and Benefit Cost Ratio (BCR)[76]. MIG farmers reached better performance for all three profitability indicators. However, the differences in the results just showed statistical significance for Net Income and ROA (see **table 4.2**).

[76] For the calculation of the costs, the authors considered the costs of production and sales, farmers' salary, and opportunity costs.

Table 4.2 − Profitability Measures

Variable	*MIG (n=15)*		*Non-MIG (n=12)*		*p-value*
	Mean	SD	Mean	SD	
Net Income(R$/month/Hectare)	65.52	128.91	-27.97	129.83	0.074*
ROA	0.03	0.05	-0.01	0.05	0.026*
BCR	1.17	0.38	0.94	0.41	0.143

**denotes significance at α = 0.10*
Note. All units are in Reais, the Brazilian currency. Exchange rate: R$2.24 to US$1.00.
Source: Own Elaboration.

The comparable economic gains obtained from MIG justify by itself the application of the system. This economics gains could be still higher in Santa Rosa de Lima by reducing some costs such as agrochemicals, which additionally would reduce environmental impacts due to the dairy activity, and enhance ecosystem services provision. The MIG has the potential to be agroecological, but it has not been the case in Santa Rosa de Lima, since MIG farmers have been using agrochemicals in pasture area and crop area for silage. Anyway, SRL's case shows the accomplishment of the level 1 of Gliessman approach, in which there is an increase of the efficiency of conventional practices to reduce the use and consumption of costly, scarce, or environmentally damaging inputs. MIG farmers in SRL are using less of these inputs per liter of milk produced. This also represents the achievement of single-loop learning, in which consider the incremental changes of established practices to improvement of performance (PAHL-WOSTL, 2009).

Once the development of sustainable alternatives is accomplished, a common sense of its necessity is desirable. Then, to create an understanding that an alternative management practice and a different relation to nature were possible, UFSC, jointly with Epagri, adopted participatory planning tools to use with local community. By that, they forced people to think explicitly about alternative situations and consider key uncertainties (MOORE et.al, 2014). For this, meetings, workshops, groups dynamics and individual conversations were conducted. These participatory process initiatives allow the improvement of the capacity to make and implement collective decisions, a characteristic of single-loop learning.

Gathering momentum /Level 2, 3 e 4 of Gliessman: This subphase includes create network to build a shared identity for those desiring transformation and create experiments in protected niches to be further scaled up (MOORE et. al., 2014). Get supporters is needed during all phases of the transformation process. To date, UFSC's project have received support, and in some cases fund, from Epagri, SRL's city hall, University of Vermont (UVM), CiVi.Net[77],

[77] A program designed by the Foundation for Sustainable Development that focused on the capacity of civil society organizations (CSOs) and their networks in community based environmental management.

University of São Paulo (USP), National Council for Scientific and Technological Development (CNPq), and Coordination for Qualification of Graduate Students (CAPES). Additionally, a local actor, a community member, was included to the project to help with community mobilization and access. The system experimentation was initially tested in five pilot farms. In 2014, year of our data collection, 53 farmers were applying MIG in SRL.

The establishment of a more direct connection between those who produce dairy products and those who consume it was not reached yet. It has to be neglected until now. Next attempts of PPs activities need to address this issue. Without that, the entire system transformation will not be possible.

4.7.1.3 Phase 3. Navigating the transition: in process

Selecting /Level 3 of Gliessman: The selection of the preferable and most promising system, considering the new social and ecological conditions that the system was submitted to, was possible by the visible advantages of the MIG system when compared to the conventional one, already mentioned in the **envisioning** subprocess. The MIG was proposed by UFSC, but its broad acceptance was evidenced by the way that the system spread among farms. It was kind natural. The university did not visit and assist all the current MIG farmers[78]. Most of them adopted the system by recognizing its economic advantages showed through the experimental farms.

Learning /Level 3 and 5 of Gliessman: This subprocess implies evaluating the results of earlier experiments and developing shared understandings or new forms of knowledge to help to inform the selection process. It is in this subprocess that the seed for a new global food system - based on equity, participation, democracy, and justice - will be sown, as well as the construction of new values and beliefs regarding to triple-loop learning. This subprocess, even is not received much attention in Moore et al. (2014)'s framework, is a key point for social transformation, because, if this step is skipped, the understanding of the overall advantages (social, ecological and economic) of a new technology can be superficial and the transformation process abandoned by the limitations imposed by the vision of a single lens, for example, the economic lens. In Santa Rosa de Lima's case this subphase seemed to be incomplete, since the activities to engage local farmers in environmental conservation was not

[78] From 21 interviewed MIG farmers, 7 knew the system through UFSC project and only 1 was still receiving technical assistance from the institution.

sufficient to change their values, beliefs and relation with nature yet. It's evidenced by the fact that the farmers are still using chemicals fertilizer, as well as herbicides.

The original proposal of MIG admits the use of agrochemicals, such as chemical fertilizer (VOISIN, 1988). However, UFSC and Epagri presented the Management Intensive Grazing to SRL's farmers as an agroecological alternative. The use of fertilizer and pesticides were ignored as needed and their use was criticized. UFSC and Epagri's justification for that lies in the fact that the amount of manure deposited on the paddocks by the cattle makes the use of chemical fertilizers unnecessary (USDA-NRCS, 2008). Additionally, the use of these chemicals destroys the soil biota that in turn is necessary for a health and reach pasture (CHIOMA et al., 2014; WANG et al., 2016). Besides of environmental health, the human health was also advocated as a good reason to do not use agrochemicals (WEISENBURGER, 1993).

Farmers applied MIG using agroecological practices initially. By that, it was possible to establish in 2002 the first organic dairy coop in SRL, which was also the first in Brazil. The organic production lasted 3 years, but due to seasonality in demand[79], the dairy coop's owners decided to produce conventional dairy products. The farmers that were producing organic milk gave up and started to produce conventional milk again.

Ninety three percent of MIG farmers are using chemical fertilizer and 100% of them are using herbicide. Even farmers that took part of the participatory process activities and were assisted by UFSC and Epagri abandoned some of the principles established for the MIG system adoption. Most of these principles aimed the reduction of the dairy system impacts on the environment. It can be a result of insufficient community mobilization and/or inadequate participatory process tools application. The process of environment empowerment and cognitive change of values and beliefs were not well accomplished, since many farmers were not assisted and part of them, even those that demonstrated more environment concerns, did not abandon conventional practices that could compromise their economic results in detriment of ecological gains. This may result of the conventional excessive emphases on the economic advantages from the MIG system adoption during the system explanation and farmers training. It is used to be the most persuasive argument.

Farmers were not asked about the reasons to keep using agrochemicals, but as mentioned in **chapter 2**, we have hypothesized some reasons: a) lack of knowledge of agroecological practices for weed management; b) no recognition, or negligence of the negative effects of the

[79] Their main demand was the municipality public school.

use of these chemical inputs on the environment and animal and human health; c) farmers are anxious for quick results; d) the farmers' fear to decrease their grass production if they do not use chemical fertilizer; and e) no recognition of the marginal reduction in soil production over the long-term by using these chemical inputs. Besides that reasons, we add the absence of environmental responsibility. On that, we refer to the recognition of humans' responsibility on the preservation, recovery and protection of nature.

Adoption /Level 2 and 3 of Gliessman: This process refers to the widespread uptake of a novel idea into the mainstream (MOORE et al., 2014). As mentioned before the process of MIG adoption in Santa Rosa de Lima was initially motived and supported by UFSC, however, a considerable part of current MIG farmers adopted the system by themselves, by recognizing the advantages of it through observation of the results of farms adopting the system around and next to their farm. There is a problematic issue on it. When the process of adoption is not assisted and conducted by its proponents, it is possible that adopters change the initial proposal according to their limitations, interests, or lack of knowledge. It seems the case of Santa Rosa de Lima. Most of farmers are not adopting the system as it was suggested by UFSC. As mentioned, they are still using agrochemicals; they are not following all the four laws of MIG system proposed by André Voisin, its mentor; and they are still feeding animals with ration and silage.

On the scale that MIG system was adopted, it has not been enough to make the system adopted by all dairy farms. It seems to be in process. 55% of the dairy farms in SRL are still applying the conventional system. The adoption of MIG in SRL has found some obstacles.

From 20 farmers interviewed in Santa Rosa de Lima, which do not apply MIG, only 5 of them did not know the system before our visit. After a brief explanation about the system, we asked them if they believe that the techniques of the system could bring environmental improvements and economic gains to their farm. All of them answered yes, they believed that it could be possible. Therefore, we asked them why they did not adopt the system and we got the following result:

Table 4.3 − Reasons presented by the farmers to do not apply MIG System

Number of farmers	*Reasons to do not apply MIG Rational Grazing System*
2	I do not know how to apply the system.
7	The system adoption is too expensive and I cannot afford it.
6	I do not have enough labor and time.
6	I feel tired due to my age to adopt a new system.
4	The land is very hilly.

Source: Own Elaboration.

The three reasons more mentioned were related to: a) economic cost to adopt the system; b) the labor required to set and manage the system; and c) the physical indisposition of farmers with advanced age. The reasons **b** and **c** are confirmed by the configuration of the family labor founded in the farms, as can be seen in the **table 4.4**.

Table 4.4 − Configuration of family labor working in the farms

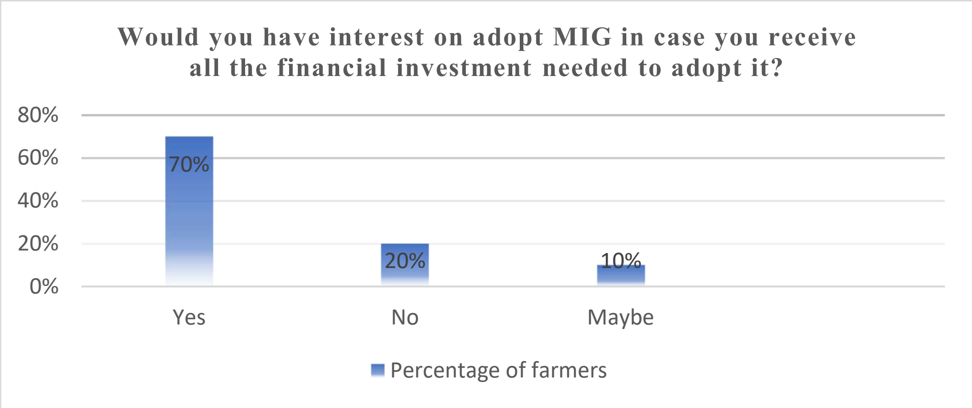
Variable	*MIG (n=21)*		*Non-MIG (n=20)*		*p-value*
	Mean	SD	Mean	SD	
Number of young family members	1.00	0.89	0.55	0.75	0.09*
Number of adult family members	2.76	0.88	1.8	1.36	0.01*
Number of elderly family members	0.66	0.73	1.45	0.99	0.006*
Total of family members	4.42	0.98	3.80	1.44	0.11

**denotes significance at α = 0.10*
Note. All units are in Reais, the Brazilian currency
Source: Own Elaboration.

Farms adopting MIG displayed more family members working in the farm than Non-MIG farms, and their family labor was majority formed by young and adult family members, while for Non-MIG farms they were majority adult and elderly family members. The differences found between the number of family members working in the farm by age was statistically significant. MIG farms have more young and adult family members working in the farm than the Non-MIG farms, while Non-MIG farms have more elderly family members working in the farm than MIG farms. Therefore, the number of family members working in the farm and the age of them justify the reasons **b** and **c** presented by the Non-MIG farmers to do not adopt MIG System.

As we can see in the **table 4.3**, 35% of the Non-MIG farmers stated that one of the reasons to do not apply MIG system is the fact that the system adoption is too expensive and they cannot afford it (reason **a**). This was the reason more quoted by the interviewed farmers. When asked about their interest in receiving the needed resource to adopt the system, 70% of the Non-MIG farmers answered that they had interest; 20% stated that even receiving the financial investment to adopt the system they did not have interest; and 10% showed to be undecided about their interest and stated that maybe they would adopt the system in case of receiving the financial support for it (**Graphic 4.1**).

Graphic 4.1 − Interest showed by farmers on MIG adoption in case of financial support



Source: Own elaboration.

As can be seen, the costs to move to a suitable dairy system in SRL are the main obstacle showed by the farmers to do not adopt it.

The transition from the conventional dairy production to MIG system demands an investment in fences, hydraulic system, drink water, and, in some cases, improvement of pasture (plantation of new grasses and leguminous). The average cost for MIG implementation is around 1,872.17 R$/hectare[80]. The average of pasture area in our area of study is 8.75 hectares, which in case of a transition from conventional to MIG would cost an average initial investment of R$ 16,381.48 for each farmer. The annual profit of Non-MIG farmers of our sample was found to be R$ 21.582,00, without including the opportunity cost and family labor. Including them, the average profit of the Non-MIG farmers sample is negative: - 4,097.40 R$/month. Their annual profit is not enough to cover MIG implementation. This investment just would be possible through the liquidation of current assets, or acquisition of a bank loan. However, it is expected that farmers are afraid to make innovation in their farm without total guarantee of success. Additionally, the time to recover this investment, if we do not consider farmers' labor and opportunity cost, would take approximately 3 years (FREITAS, 2009).

Based on the data showed for SRL study case, the farmers that currently adopt the conventional dairy system, predominantly, did not move to MIG system because they do not have the financial capital for that. But, since the MIG system generates ecosystem services and is less

[80] It was found in the literature different costs for MIG implementation according to three different researches: 963.44 R$/hectare (MACHADO, 2004), 3,565.08 R$/hectare (DIAS, 2014), and 1,088/hectare (MOURA, et. al , 2014); which justify the average cost of 1,872.17 R$/hectare. The cost presented by Machado (2004) was adjusted to 2014, considering the inflation rate, the same year of our data collection and other sources. Exchange rate for the period: R$2.24 to US$1.00.

environmentally damaging, when appropriately adopted, the payment for ecosystem services (PES) emerges as an alternative to provide the resources needed for that transition.

4.7.1.4 Phase 4. Institutionalizing the new trajectory: in process to start

Routinization /Level 3 of Gliessman: This subprocess is characterized by the standardization of new practices adopted for a new trajectory (MOORE et. al., 2014). The authors emphasize the need of funding and people to accomplish this stage. As mentioned before, there is an economic cost for MIG transition that sometimes the farmer cannot afford. Additionally, participatory processes and extension activities demand many resources, which have been until now been sponsored by academic institutions, such as CNPq, CAPES and CiVi.Net. However, much more fund is still needed to accomplish this phase. For that, UFSC, jointly with UVM and USP, have considered PES as an alternative of funding source for the system expansion, extension activities and participatory process activities needed for the correct application of the system, as well as the environmental responsibility empowerment.

On the ecological elements, we have some evidences based on farmers' perception that MIG system, even in the SRL case that was not fully adopted as was recommended, is more sustainable than the conventional one. When asked about soil conditions and pasture quality, MIG farmers stated that the soil of their pasture area have showed more porosity, humidity, and presence of small animals, such as insects; and the forage was better in quality and quantity, this has also been confirmed by Alvez (2012). On animal health, MIG farmers also perceived improvement after MIG system adoption. They verified less cases of mastitis and tick contamination, for example.

The improvement of the dairy system achieved by experimenting with MIG and the inclusion of ecological variables in the measure of performance shows evidences of double-loop learning, in which there is a revisiting of assumptions and a reflection of goals and problem framing (PAHL-WOSTL, 2009). The double loop-learning seems to be in process in SRL's case, since the adoption of MIG was not applied ecologically as recommended by its proponents, and the ecological variables were not formally introduced in the measures of performance. This idea has been in construction during the meetings accomplished with farmers.

Strengthening cross-scale relationship /Level 3 and 4 of Gliessman: This subprocess involves scaling up the change, which often involves a different type of innovation than was created originally in niche. Additionally to MIG adoption, UFSC has considered silvopastoral technique and living fences to integrate their original idea (Pitton et. al., 2014.a, 2014.b). The objective is improving animal wellbeing by produce shadow for animals, and provide ecosystem services such as carbon storage, animal habitat, firewood, and fruits (SCHMITT et al, 2013). These ideas are still in testing phase in four farms.

Stabilization /Level 4 and 5 of Gliessman: For this subprocess it is expected a "change that is global in scope and reaches beyond the food system to the nature of human culture, civilization, progress, and development" (GLIESSMAN, 2016). It is also expected a change in the underlying norms and values (triple-loop learning).

Even transformation process reaches stability, this phase cannot be seen as a final end point, since resistance can appear, as well as unintended consequences may occur (MOORE et. al, 2014). The social-ecological system transformation of SRL dairy system has not been achieve stability yet, neither triple-loop learning. For that, the agents interested in this transformation need to "push for small 'wins' in achieving a more sustainable trajectory and resists attempts by others to keep redefining or reverting from the potential transformation" (MOORE et. al., 2014, p. 6). The use of agrochemicals by MIG farmers is a type of resistance that compromised the trajectory of transformation desired by the MIG system proponents in Santa Rosa de Lima. Extensive work needs to be done in order to bring farmers back to the road of transformation. A new paradigm needs to be established. For that, new attempts of participatory processes are recommended. The costs for the system implementation is also an obstacle to the system stabilization, as was previously mentioned. For that, PES once more appears to be a possible funding source.

4.7.2 Potential of PES to Contribute for Social-Ecological System Transformation of the Dairy System in SRL

Once the implementation of an agroecological dairy system would benefit not only the farmer, but also the society due to the reduction of impacts of the activity on the environment and the generation of some ecosystem services, the payment for ecosystem services to encourage this transition seems to be justified (SCHMITT, et al., 2013). Based on this assumption, Brasileiro, et al. (2013) made a brief diagnosis to evaluate the real conditions to development and implement a Program of Payment for Ecosystem Services (PPES) to encourage dairy farmers to adopt an agroecological system in Santa Rosa de Lima municipality. The results of their diagnosis showed that there are many favorable factors to the implementation of a PPES, such as: a) the importance of the Atlantic Forest biome for the generation of ecosystem services, in which the municipality is placed; b) the potential of the MIG system to generate ecosystem services; c) the existence of potential providers of the ecosystem services (dairy farmers); d) the existence of potential buyers of the ecosystem services (Government, for example); e) the organizational level of the local community; f) the legal land tenure of the dairy farmers; g) the indication of future formation of a Fund for Payment for Ecosystem Services in Santa Catarina State guaranteed for the State Law number 15.133; and h) the legal support for payments for ecosystem services presented in the state and Brazilian law number 12.651 and 15.133, respectively. The authors propose a PPSE in which dairy farmers receive a payment for ecosystem services provision to support them with the costs needed to implement the MIG during the period of the return of the investment similar to what is proposed by Schmitt et al.(2013) to the same region.

The Brasileiro et al. (2013)'s PES proposal for SRL's dairy system corroborates with Muradian et al (2010)'s definition of PES and the reaches expected with its implementation. Firstly, the authors assume that environmental services also can be generated by managed ecosystems services, such as sustainable agricultural practices. Second, in their arguments, PES can work as an incentive for sustainable practices in agroecosystems. Finally, the PES has also to object poverty alleviation. As mentioned before, the dairy production in Santa Rosa de Lima's case has not presented profitability in many cases when the family labor is included in the production costs for Non-MIG farmers, making the average profit for these farmers negative[81]. Additionally, the impact of the dairy activity on the Atlantic Forest, where the municipality of Santa Rosa de Lima is located, has compromised the health of ecosystem services of this biome historically threatened by the economic development and urbanization (SOS MA, 2017). Therefore, a PES scheme to encourage the implementation of a more profitable and sustainable dairy system in Santa Rosa de Lima seems to be desirable and recommended.

The payment for ecosystem services could also provide some resources required to develop actions needed in all phases showed by Moore et al. (2014)'s framework on social-ecological system transformation, except for the first phase that it is the recognition of system disruption

[81] Only 41% of the Non-MIG farmers, which participated of our sample, presented positive profit when included the family labor into the production costs.

(**Table 4.1**). The financial capital would be needed for research on the limits of the current system, development of new techniques, analysis of the MIG adoption results, meetings, workshops and speeches among academic scientists, government and community, for example.

However, as was previously mentioned in the 4.4.1 section, PES has some limitations and sometimes can generate negative outcomes, since the responsibility on the environmental recover and preservation is conditioned to the payment. It occurs because this environmental responsibility is not empowered by the ecosystem services providers, and self-interest predominates. In this context, the social learning emerges as an indispensable condition to promote the changes in the relationship between human and environment.

4.7.3 Potential of Participatory Processes to Contribute for the Socio-Ecological Systems Transformation of The Dairy System in SRL

Since participatory processes (PPs) seeks to create the environment for social learning, which can promote cognitive change of actors' values and beliefs and, consequently, collective action, PPs can be considered as an important tool for the social-ecological system transformation of the dairy system in Santa Rosa de Lima. Additionally, the PPs could also address some limitations of the PES scheme, such as: a) creating social conditions to engage community in natural resource management; b) building ties of trust among sellers, buyers and intermediaries of PES schemes; and c) promote social empowerment on environmental responsibility and sustainable techniques. These are seen as essential for the PES success.

As mentioned in the section 4.7.1.3, the participatory process activities accomplished until now did not create the complete conditions for value and belief changes needed for social-ecological system transformation, since some environmentally harmful techniques are still being in use. However, some differences were found among MIG and Non-MIG farmers which evidences that PPs are still a promising tool. It can be identified by farmers' perception on ecosystem services provided by forest (**table 4.5**).

Ninety-five percent of MIG farmers were able to identify at least one benefit from forest to their farm. This percentage for Non-MIG farmers was 85%. When specifically asked about the benefits from the forest to farm, MIG farmers were able to identify, on average, 2.7 benefits, and Non-MIG farmers recognized 1.78 benefits. This difference was statistically significant, with a p-value of 0.02. The tree most mentioned benefits were: biodiversity maintenance, water availability and water quality for both groups. On provisioning ecosystem services, MIG farmers mentioned on average that they harvest from forest 2.33 items, and Non-MIG mentioned 1.45. This difference was statistically significant too, with a *p*-value of 0.10. The most mentioned were: fruits, firewood, water for animal consumption and wood for both groups (see **table 4.5**).

For Areas of Permanent Preservation (APP)[82], most farmers from both systems disagreed with the Brazilian forest code. The percentage of farmers' agreement on Legal Reserve[83] was higher for both systems when compared to Permanent Preservation Areas, and it was still higher for MIG farmers (see **table 4.5**).

Table 4.5 − Famers' perception on forest benefits and concordance on Forest Code

Variable	*Average or Percentage*		*P-value*	*N*		*Test*	*Source*
	MIG	**Non-MIG**		**MIG**	**Non-MIG**		
Perceived benefit from forest to the farm	95%	85%	0,52	21	20	U	I
Number of benefits perceived from forest to farm	2.71	1.84	0.03*	21	20	T	I
Number of items harvested from forest	2.33	1.45	0.10*	21	20	T	I
Agree on riparian area requirement	10%	10%	0.338	21	20	U	I
Agree on water sources requirement	29%	25%	0.145	21	20	U	I
Agree on requirement for area of 45 degrees of declivity	5%	10%	1	21	20	U	I
Agree on LR requirement	62%	35%	0.091*	21	20	U	I

I - Interview
****significance at α = 0.10***
Source: Own elaboration.

The differences founded between MIG and Non-MIG farmers can partially show that, even they did not still empower the idea of environmental responsibility, the MIG farmers in some way are closer to that than Non-MIG farmers. This reach is corroborated by the differences in the percentage of farmers that showed interest in taking part of a PES scheme to recover and protect forest and permanent preservation areas. Although the difference was statistically significant just for PES program to preserve native forest, the percentages were higher for MIG farmers in all categories of PES that was presented to them (see **table 4.6**). These results once more show potential for PES implementation in SRL's case, since the first condition for the success of the PES scheme is the willingness of farmers to take part in it.

[82] APP is protected area, covered or not by native vegetation, with the environmental function of preserving the hydric resources, the landscape, the geological stability and the biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations. The APP includes riparian areas, areas around springs and lakes, hilltops, steep slopes, and areas of high elevation (BRASIL, 2012).

[83] LR is the area located inside of a property or rural tenure with the function of ensuring the sustainable economic use of natural resources in the rural property, supporting the conservation and rehabilitation of ecological processes and promoting the biodiversity conservation, as well as the habitat and protection of wildlife and native flora (Brazil, 2012).

Table 4.6 -Willingness to participate in a PES program

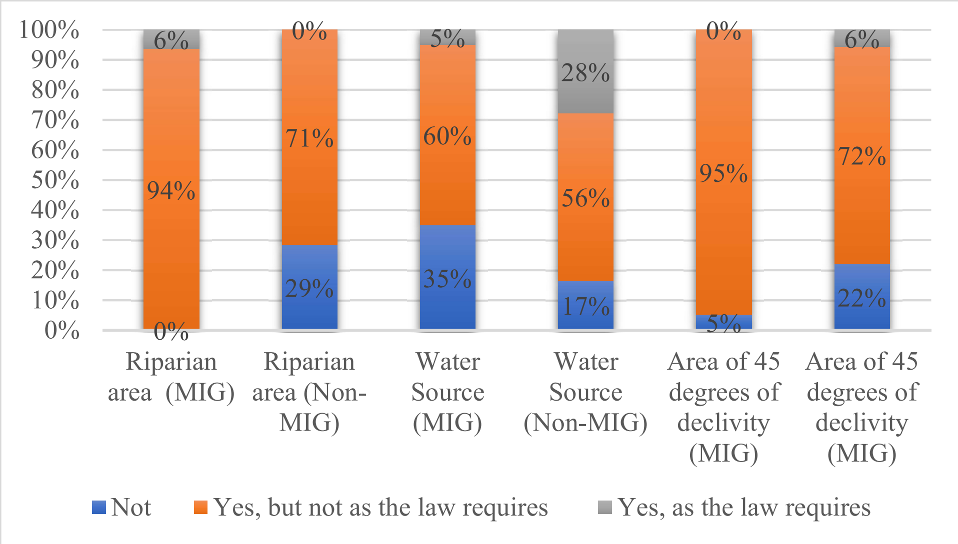
Variable	*Average or Percentage*		*P-value*	*N*		*Teste*	*Source*
	MIG	**Non-MIG**		**MIG**	**Non-MIG**		
Present any Interest in take part in a PES program to preserve native forest (probably, sure)	90%	65%	0.004*	21	20	U	I
Present any interest in take part in a PES program to recover deforested area with native forest (probably, sure)	62%	40%	0.164	21	20	U	I
Willingness to receive to comply the riparian area requirement (sure, maybe)	86%	65%	0.200	21	20	U	I
Willingness to receive to comply with the water sources requirement (sure, maybe)	90%	70%	0.226	20	20	U	I
Willingness to receive to comply the requirement for area of 45 degrees of declivity (sure, maybe)	86%	70%	0.381	21	20	U	I
Willingness to receive to comply the LR requirement (sure, maybe)	95%	70%	0.254	21	20	U	I

AP – Accounting Project
I- Interview
NA- Not applicable
****significance at α = 0.10***
Source: Own elaboration.

On forest code's compliance, for riparian area, water source and area of 45 degrees of declivity, we found that all farmers are majority protecting these areas, but not exactly as the law requires[84], and the percentage of this condition is higher for MIG farmers. Except for water source, the number of farmers that are not protecting these areas is higher for Non-MIG farmers (see **graphic 4.2**). Applying a Mann Whitney U test for the two types of system, the *p*-values found for the riparian area, water source and area of 45 degrees of declivity compliance was 0,0, 0,94 and 0,0, respectively. So, for water source they displayed no differences on law compliance.

[84] For LR, the Law Nº 12.651 requires that rural properties in the Atlantic Forest biome maintain 20% of their total area in native vegetation. For APP, the requirements are: at least 30m of riparian area along of rivers and around lakes; a minimum radius of 50m around natural water sources; top of hills, hills, mountains and mountain ranges with a minimum height of 100 meters and average slope greater than 25°; cliffs or parts of them with slopes above 45 °; the sandbanks; the edges of trays or plateaus in a range never lower than 100 meters from the relief break line; and in areas with altitude above 1800 meters (BRASIL, 2012).

Graphic 4.2 – Forest Code's compliance by farmers



Source: Own elaboration

These indicators partially indicate the degree of environmental responsibility among farmers, which can be result of taking part in UFSC and Epagri's project to establish an agroecological dairy system in Santa Rosa de Lima, or being in contact and/or receive some guide from those which participated of the project.

As can be realized, MIG farmers seems to be more inclined to contribute for nature conservation and restoration than Non-MIG farmers. However, the level of this commitment is still insufficient to a deep social-ecological transformation of dairy system. Since the process of learning is continues and progressive, more participatory activities need to take place. In this context, participatory process shows high potential for contribution.

4.5 CONCLUSION

It seems clear that a process of social-ecological dairy system transformation is occurring in Santa Rosa de Lima. Applying Gliessman (2016)'s approach, SRL's dairy system seems to have reached level 1 and, partially, level 2 of the food system conversion process, since many farmers have already applied an alternative practice and have initiated the process of reducing the use and consumption of costly, scarce, or environmentally damaging inputs.

Based on Moore et al.(2014)'s framework it is possible to identify in which stage the transformation of SRL's dairy system is situated. It has already reached phase 1 (Triggers or Pretransformation); partially concluded phase 2 (Preparing for change); the phase 3 (Navigating the transition) seems in process; and phase 4 seems in process to start. It is possible to conclude that due to: a) the partial recognition of the unviability of the conventional dairy system resulting of the social-ecological system disruption; b) the development and application of a new and more sustainable technique (MIG); c) the development of social networks among famers, researchers (UFSC, USP, and UVM), and government agencies (Epagri); d) ongoing researches to evaluate the reaches and need of improvement of the MIG Project in Santa Rosa de Lima (SCHRÖTER et al.; 2015; BRASILEIRO et al., 2013; ALVEZ, 2012, ALVEZ et al., 2014; SCHIMITT et al., 2013); e) meetings and workshops accomplished with farmers to sharing and construction of new knowledge; and f) efforts to replicate the MIG System, which was successful in experimental stage (44.5% of SRL's famers are already applying MIG).

It is very complex to measure the level of learning (single-loop, double-loop or triple-loop), but based on the fact that MIG farmers have incremented improvement of established routines, it is possible to state that MIG farmers have already reached the single-loop learning. They also seem to be in the process of a double-loop learning, since they have been reflecting on actions and assumptions (conventional versus MIG system) within a value-normative framework (produce more, for less, including less environmental damage). The fact that MIG are more prone to meet environmental law and is more able to recognize environmental benefits from nature than Non-MIG farmers can be an indication of social learning reaches, double-loop learning. On other hand, it is important to emphasize that, it seems, farmers started to apply MIG, and are still applying that, by recognizing that it can be more economically advantageous, so the self-interest is still the driver of such decision.

The evidence that MIG farmers did not have a complete change in value and beliefs lies on the fact that they extract from the experience brought by UFSC and Epagri the aspects of the system that could contribute to their production and abandoned the practices that had predominantly benefits only to the environment. It shows that the environmental responsibility was not deeply empowered by farmers. However, it is important to mention that the process of change of values is gradual and slow. One cannot expect change values, built during centuries, in twenty years. PPs need to be conducted intensively and frequently.

Even the social-ecological dairy system transformation of SRL seems to be in the middle of the process, much still may be done to achieve the complete transformation of the system. We have analysed predominantly farmers' behaviour and perception, however many other actors are involved in this process. It is possible to see the representation of academics and government by the participation of UFSC, UVM, USP and Epagri in this, but the agri-food system encompasses also consumers, processors, distributors, wholesalers, retailers, etc. Additionally, not all of the farms are already applying the alternative system, the scope of the transformation need to embrace all the municipality dairy farms, or at least the majority. And the farmers that are already applying the system are not doing that, necessarily, because believe it is better to the environment, but because it is more profitable. The dairy food system's actors need to share and empower the responsibility on environmental concerns.

Analysing the social-ecological system transformation of SRL's dairy system we found demands for financial capital. In this context, there is potential for a PES scheme implementation to provide the financial capital needed to that transition process, since MIG brings social benefits, which justify the adoption of this tool. Additionally, the first condition for a PES success has been already reached: the acceptance of farmers in taking part of a PES scheme.

The results of the implementation of PES in Costa Rica for regeneration of forest and efficient use of natural resources, shows the potential of this tool for social-ecological system transformation to more than just provide financial capital. Rosa, Kendel and Dimas (2003) mention that besides the regeneration of forest and improvement of the efficiency in the use of natural resources, the project has foster: a) social innovation processes in the environmental and forestry sector; b) municipal capacity for assuming local environmental management; c) associative efforts to link interests; d) environmental responsibility of NGOs, producers and companies; and e) technical innovations.

Experiences of PES in Mexico, United Sates, Brazil, El Salvador and Costa Rica shows that is necessary to strength community strategies for ecosystem services management to get success of PES schemes (ROSA; KENDEL; DIMAS, 2003). Additionally, as mentioned before, PES applied without an empowerment of environmental responsibility can create a reverse effect. In view of those, and in view of the demand of values change for the reach of a social-ecological system transformation, social-learning emerges as indispensable. In this context, PPs seems recommended, since it can create the environmental conditions for social learning, environmental responsibility empowerment, and consequently collective action. This is corroborated by evidences of social-learning reaches due to some PPs initiatives already accomplished in Santa Rosa de Lima.

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CHAPTER 5

GENERAL CONCLUSIONS

5. GENERAL CONCLUSIONS

From the analysis of the accounting project applied in Santa Rosa de Lima (SRL), in Santa Catarina State, we conclude that Management Intensive Grazing (MIG) showed statically significant better performance for the majority of the economic variables than the conventional dairy system (non-MIG), such as Net Income I/hectare, Net Income II/hectare and animal unit, and Return on Assets I, II and III. However, the Return on Assets, which represents the return in profit for each monetary unit of investment on assets, was still very low with regards to the interest rate on savings, in general, due to the high investment on assets of the activity. It means that, in this context, it is more advantageous to sell all assets and invest money in a saving accounting, which will generate more return, than to invest in the dairy activity, even if applied MIG. It can be an evidence that: a) farmers are not aware of the real return of their business to be able to decide what is the best economic option; b) land values are increasing rapidly, so maintaining ownership of the farm is important; and c) farmers simply enjoy their work and can sustain themselves on it, so maximizing monetary returns is not their main goal.

The last alternative brought us back to the statement of one farmer in the beginning of the accounting project: “I’m glad to contribute for the research, but I don’t care if I’m having profit. I like to work with cows and I won’t give up even if you tell me I’m using my retirement salary to feed cows and heifers, because I already know that”. It means that farming does not even compete with keeping money in a savings account. It shows that, contrary to conventional idea of *homo economics,* the motivators for business decision is not always inside of the economic rationality. Emotional elements influence in the farmers decision on which invest money, work and land. It deserves more attention for future investigations and has also to be considered when designing alternatives for land use.

MIG farmers are producing 80% more milk per hectare than non-MIG farmers. However, as the system has been applied in SRL, it cannot be considered as a sustainable intensification system, nor an agroecological one. Differently than what was proposed to SRL by UFSC and Epagri, MIG farmers are still using agrochemicals and are dependent on off-farm inputs, such as animal feed. Despite of it, MIG can produce more per hectare, which shows potential to spare land for forest recovery and reduce pressure on remaining forest. Satellite images (**Figures 3.4, 3.5** and **3.6, chapter 3**) showed that “others area”, which include pasture, has decreased over years, and have been replaced by planted forest and native forest. This fact summed to the increase of 52% of milk production in SRL, mentioned before, can be an evidence of the replacement of other agricultural uses by milk production, or an evidence of the use of more efficient dairy systems, such as MIG. If this last is true, we do not have a case of sustainable intensification, but we have a land sparing experience.

Nevertheless, protected areas are not enough to guarantee biodiversity conservation if areas around the forest fragments are not permeable (PERFECTO;VANDERMEER, 2008). Due to that, principals from the land sharing strategy has to be combined with land sparing to reach the objectives of biodiversity conservation, by that we refer to agroecological practices, organic production, and agroforest, for example. Additionally, considering the type of matrix we are analyzing (pasture), this seems still more recommended. Pasture is not a favorable matrix to the migration of some species, due to the frequent grazing (SANTOS, 2014). MIG farmers perceived better environmental conditions (porosity, humidity, presence of little animals) in their pasture area and have more plant diversity, but it is not enough to ensure matrix permeability. In this context, silvopastoral systems, added to agroecological practices, emerge as alternative to improve the quality of pasture area for interpatch animals migration in Santa Rosa de Lima, which is indispensable for biodiversity conservation (CUNHA; GUEDES, 2013).

For the context of SRL, a mix of MIG system with agroecological practices and silvopastoral systems can be envisioned as a solution for balancing the goals of promoting farmers livelihood, biodiversity conservation and ecosystem services provision. This sustainable intensification strategy needs to be paired with conservation programs to ensure that land will be converted in native forest, without that, there is no guarantee that farmers will not simply enhance their production, or still convert pasture area in other economic alternative use.

SRL's dairy system seems to be in process of conversion from an extensive pasture-based system to intensification sustainable one, and from conventional dairy system to an agroecological one. Analyzed by the lenses of the ecological system transformation process, it is possible to identify elements that evidence this transition. First, there is a partial recognition of the unviability of the conventional dairy system resulting of the social-ecological system disruption. It is partial because not every farmers have recognized it, and some of those who has recognized is not able to identify all of the problematic roots of this disruption. In view of this recognition, universities and governmental institutions have worked in implementing and spreading a new and more sustainable technique (MIG), which also characterize other aspect of the transformation process: the development of social networks among famers, researchers (UFSC, UVM, USP, CiVi.Net), and government agencies (Epagri). Evidencing the process of transformation, we still have the ongoing researches to evaluate the reaches and need of improvement of the MIG Project in Santa Rosa de Lima by partner academic institutions, and the meetings and workshops accomplished with farmers to share and construct new knowledge. Finally, we have efforts to replicate the MIG System, which was successful in experimental stage (44.5% of SRL's famers are already applying MIG).

The process of social-ecological system transformation needs time to be set up, mainly because cognitive changes, such as values and beliefs, are needed, and that is not expected to happen promptly. The way in which we relate to each other and to the environment is oriented by those values and beliefs. Without cognitive changes, it is not possible to believe in a real transformation. This can be achieved by social learning processes (MURO; JEFFREY, 2008), which sequentially is capable to promote single-loop, double-loop or triple-loop learning (PAHL-WOSTL, 2009).

In SRL's case, it was possible to identify that farmers have reached some levels of learning, based on the fact that MIG farmers have incremented improvement of established routines (evidence of single-loop learning); and they have been reflecting on actions and assumptions within a value-normative framework - produce more, for less, including less environmental damage - (evidences of a start for a double-loop learning). Additionally, MIG farmers showed to be more prone to meet environmental law and are more able to recognize environmental benefits from nature than non-MIG farmers (evidences of double-loop learning). However, it is important to mention that farmers started to apply MIG, and probably are still applying that, by recognizing that it can be more economically advantageous, so maybe the self-interest is still the main driver of such decision. That deserves more detailed investigation. If it is confirmed to be true, work has to be done to make farmers aware of all the environmental benefits derived from the implementation of an agroecological system. Additionally, farmers have to be aware of their social responsibility on environmental preservation.

In this context, participatory processes (PPs) can be an useful tool, since it can create the favourable environment for the collective process of learning (MOORE et al. 2014). Through more speeches, meetings, group dynamics, collective planning of actions, participatory research, and participatory actions among different actors of the agri-food system is possible to share knowledge and create new ways of thinking, resulting in cognitive changes.

All these demand financial resources, which are also needed for supporting other elements of the social-ecological system process transformation, such as application and replications of new techniques, for example, an agroecological silvopastoral MIG system. For the origin of these financial resources, Payment for Ecosystem Services (PES) is advocated as a suitable tools, since the benefits that the adoption of agroecological practices provides justify a PES scheme. The first condition for the success of a PES program is the willingness of farmers to participate in that. Condition already met in SRL's case. The majority of MIG and non-MIG farmers showed interest in receiving a payment to not use economically areas defined as area of permanent preservation, and some of them showed interest in receiving to recover forest area.

In summary, MIG system, which in the SRL's case is not agroecological, is already more profitable than the conventional one, but to promote ecosystem services and help with biodiversity conservation, the dairy system needs to have its matrix quality improved. It can be achieved by applying additionally friendly farming, such as agroecology and silvopastoral systems. This process for the system conversion has already started, but need elements to support it, such as financial capital and social-learning, which can be attained through PES and PPs, respectively.

SRL is an interesting case study to allow us to understand these different approaches and built an analysis framework to see that the transition to agroecological MIG should include social-learning process through the use of economic, social and environmental tools.

Besides this thesis, the results of the present research include the Accounting Project, an extension activity, conducted with farmers during one year, in order to, in addition to collect data, teach them on accountancy and activity economic performance. Each farmer received the accounting report of his/her activity, and we presented to them the aggregated values for milk production in SRL collected during this Accounting Project.

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ATTACHMENT A – Questionnaire Applied to MIG Farmers

Diagnóstico Conjunto - Caracterização da propriedade e Percepção do produtor sobre a implantação do Pastoreio Voisin, Serviços Ambientais, Legislação Ambiental, Produção Orgânica e Pagamento por Serviços Ecossistêmico.

Realização: PROCAM (USP), UFSC, GPVoisin, GUND (UVM) e CiVi.net

I – IDENTIFICAÇÃO

Entrevistadores:	Data:
1. Nome:	2. Data de nascimento:
3. Nome do esposo (a):	4. Data de nascimento:
5. Comunidade:	6. Município:
7. Microbacia:	8. Telefone:
9. Projeto do Laticínio:	10. Área total da propriedade:
11.Georreferenciamento (WGS84): Lat___________________________ Long___________________________	

II – CARACTERIZAÇÃO FAMILIAR, DO TRABALHO E DE GÊNERO

12. Quantas são, qual a idade e gênero das pessoas que compõem a família?

Gênero	Até 10 anos	11 a 20 anos	21 a 30 anos	31 a 40 anos	41 a 50 anos	51 a 60 anos	61 ou mais
Feminino							
Masculino							

13. Algum membro da família tem alguma atividade econômica fora da propriedade? a. Sim b. Não
14. Quantos membros da família trabalham exclusivamente na propriedade?
15. Quantos membros da família trabalham parte do dia na propriedade?
16. Vocês contratam pessoas para trabalhar na propriedade? a. Sim b. Não 17. Quais os meses? ☐ Jan. ☐Fev. ☐ Març. ☐Abril. ☐Maio. ☐Junh. ☐Julh. ☐Agos. ☐Set. ☐Out. Nov. ☐ Dez.
18. Quantos membros da família têm alguma fonte de renda que não seja decorrente da atividade na propriedade (incluindo pensionistas)?
19. Quantos membros da família estão morando fora da propriedade? 20. Qual o motivo? a. Estudar b. Trabalhar c. Melhorar condição de renda d. Vontade e Outro:

III – GESTÃO E CARACTERIZAÇÃO ZOOTECNICA

21. Interesse econômico: a. Bovinocultura de leite b. Outro interesse:
22. Composição racial: a. Holandês b.Jersey c. Pardo-Suiço d.Gir Leiteiro e.Girolando f.Gado Mistiço g. SRD.
23. O senhor(a) participa de alguma associação de criação de animais?Qual?
24. O (a) senhor(a) faz controle contábil da atividade leiteira? a.Sim, contador b Não faço c.Sim, participo do CONTAGRI da Epagri d.Sim, utilizo software específico e. Sim, utilizo caderno de anotações
25. O(a) senhor(a) faz controle leiteiro? a. Sim, diário b. Sim, semanalmente c. Sim, quinzenalmente d.Sim, mensalmente e. Outro: _______________ f. De vez em quando g. Não h. NSRP Obs: Entregar um modelo
26. Desde quando você produz leite?

Item	Antes da impl. do projeto	Após a impl. do projeto	Observações
27.Área efetiva			Soma das áreas utilizadas para a criação animal.
28.Produção TOTAL de leite l/dia			
29.Composição do rebanho			

a. Vacas			
b. Novilhas			

IV – ASSISTÊNCIA TÉCNICA

30. Quem presta assistência técnica para a sua propriedade? a.Epagri b.GPVoisin c.Cooperativa d.Prefeitura e. Laticínio f. ONG g. Empresa contratada h. Agropecuária i. NDA j. NSRp
31. Como é a qualidade da assistência técnica realizada? a.Muito boa b.Boa c.Razoável d.Ruim e. Muito ruim f. Não recebo assistência técnica g. NSRp
32. A sua propriedade recebe assistência médico-veterinária? a.Sim b.Não c.Empresa:
33. Como é a qualidade da assistência médico-veterinária recebida? a. Muito boa b.Boa c. Razoável d.Ruim Muito ruim e. Não recebo assistência médico veterinária f. NSRp

V – CARACTERIZAÇÃO DO PROJETO DE PASTOREIO VOISIN

34. Como o(a) senhor(a) ficou sabendo do Pastoreio Voisin? a. Televisão, jornal; b. Extensionista da Epagri; c.Técnico da prefeitura; e. Técnico do laticínio; f. GPVoisin; g. Algum conhecido; h. não soube responder.
35. Há quanto tempo o senhor (a) adotou o Sistema de Pastoreio Voisin?
36. Quantos piquetes o projeto tem? Quantos foram construídos?
37. Tem água em quantos piquetes? a.todos b.metade c.quase todos d.nenhum 38. São Móveis ou fixos? a. móvel b. fixo
39. Você acredita no projeto que está implantando em sua propriedade? a.Sim b.Acredito fortemente c.Não acredito c.Tenho dúvida d. NSRp
40. O dia-de-campo é importante para trocar informações com os técnicos e agricultores? a.Sim b.Nao, não é c. É muito importante d. É, mas eu nuca vou e.Vou a todos que posso f. Era importante só no inicio do Projeto.

VI - QUANTO AO MANEJO DO PASTOREIO VOISIN

41. Antes de decidir em adotar o Pastoreio Voisin em sua propriedade, o que achava sobre a dificuldade de implantar o projeto? a.Muito difícil b.Difícil c.Razoável d.Fácil e. Muito fácil
42. Depois da adoção do Pastoreio Voisin em sua propriedade, o que acha sobre a dificuldade na implantação? a.Muito difícil b.Difícil c.Razoável d.Fácil e. Muito fácil
43. Antes de decidir em adotar o Pastoreio Voisin em sua propriedade, o que achava sobre a dificuldade de manejar o rebanho neste sistema? a.Muito difícil b.Difícil c.Razoável d.Fácil e. Muito fácil
44. Depois da adoção do Pastoreio Voisin em sua propriedade, o que acha sobre a dificuldade de manejar o rebanho no novo sistema? a.Muito difícil b.Difícil c.Razoável d.Fácil e. Muito fácil
45. Em sua opinião o que mais dificultou a adoção do Voisin? a. Falta de Recurso Financeiro b.Falta de conhecimento técnico c. Medo de mudar para um sistema de produção diferente d. Outro:
46. Qual foi a principal razão que o levou a adotar o sistema Voisin? a. Promessa de maiores ganhos econômicos b. Prejuízo financeiro no antigo sistema c. Melhorias ambientais d. Outro:
47. Em uma escala de 1 a 5, diga-me quanto você confia no conhecimento das seguintes pessoas que vieram a sua propriedade para lhe ajudar na adoção do projeto de Pastoreio Voisin (atribua 0 para aqueles que não foram à sua propriedade dar algum tipo de assistência): a)Acadêmicos da UFSC_______ b) Extensionista da Epagri_______ c) Técnico do laticínio __________ d) Técnico da prefeitura________ e) Integrantes do GPVoisin:_______
48. O senhor (a) teve algum tipo problema com a vizinhança por conta da implementação do sistema Voisin? Como?

VII – QUANTO À PRODUÇÃO ORGÂNICA

49. O(a) senhor(a) sabe o que significa produto orgânico? a.Sim b.Não c.Acho que sim d.Nao tenho certeza
50. Produz leite orgânico (ou agroecológico)? a.Sim b.Não, mas tenho interesse em produzir c.Não, não tenho interesse d.Acho que deve ser muito caro e.Acho que deve ser difícil f. NSRp
51. Se produz de forma orgânica, que instituição certifica a produção? a.IBD b.Ecocert c.Rede Ecovida d. A produção não é certificada e.Estou em transição com a certificadora:____________________ f.NSRp
52. Há quanto tempo o senhor produz leite orgânico?
53. O(a) senhor(a) sabe o que é homeopatia? a. Sim b.Acho que sim c. Não d. não tenho clareza

54. O(a) senhor(a) sabe o que é fitoterapia? a. Sim b. Acho que sim c. Não d. não tenho clareza			
55. O(a) senhor(a) utiliza em seu rebanho medicamentos homeopáticos e fitoterápicos?			
56.	Medicamentos fitoterápicos.	Medicamentos homeopáticos	Medicamentos convencionais.
Antes do projeto			
Após o projeto			
57. Há quanto tempo utiliza fitoterápicos e homeopaticos? Fitoterápicos: homeopáticos:			
58. Acha que estes produtos são confiáveis? a. não b. sim c. talvez d. NSRp.			

VIII – QUANTO A PRODUÇÃO DE LEITE, PASTAGEM, COMPORTAMENTO E ALIMENTAÇÃO

59. A adoção do Pastoreio Voisin possibilitou aumento do rebanho? a. Sim b. Não c. NSRp
60. O Pastoreio Voisin possibilitou aumento da produtividade de leite por animal? a. Sim, aumentou b. Sim, aumentou bastante c. Manteve-se constante d. Não, diminuiu e. Não, diminuiu bastante f. NSRp
61. Após o Pastoreio Voisin houve aumento da produção diária de leite? a. Sim, aumentou bastante b. Sim, aumentou c. Manteve-se constante d. Não, diminuiu e. Não, diminuiu bastante f. NSRp.
62. Após a adoção do Pastoreio Voisin, o que aconteceu com carga de trabalho diária? a. Aumentou b. Aumentou muito c. Manteve-se constante d. Diminuiu e. Diminuiu muito f. Igual mas é menos penosa f. NSRp.
63. O que aconteceu com o comportamento dos animais, após a adoção do Pastoreio Voisin? a. Igual b. Ficaram mais dóceis c. Ficaram mais contentes d. Ficaram mais difíceis de lidar e. NSRp.
64. O que aconteceu com a pastagem após a adoção do Pastoreio Voisin? a. piorou b. melhorou a qualidade f. não mudou c. aumentou a quantidade d. aumentou muito a qualidade e quantidade e. diminuiu muito a qualidade e quantidade.

65. ALIMENTAÇÃO	**Verão**	**Inverno**
Pastoreio	sempre ( ) restrito ( ) hs/dia:____	sempre ( ) restrito ( ) hs/dia ___
Capineira	N ( ) S ( ) Kg/dia:______	N ( ) S ( ) Kg/dia:________
Silagem de _________	N ( ) S ( ) Kg/dia:______	N ( ) S ( ) Kg/dia:________
Concentrado	N ( ) S ( ) Kg/dia:______	N ( ) S ( ) Kg/dia:________
Concentrado	todos animais (.....) por categoria: ( ) Qual categoria: ___________	Todos animais (.....) por categoria: ( ) Qual categoria: ___________

66. Faz sobressemeadura no pasto no Verão? N (.....) S ( ) - ( ) Leguminosa ( ) gramíneas // Quais:
67. Faz sobressemeadura no pasto no Inverno? N (.....) S ( ) - ( ) Leguminosa ( ) gramíneas // Quais:
68. Faz sobressemeadura área Milho? N (.....) S ( ) - ( ) Leguminosa ( ) gramíneas // Quais:
69. A sobressemeadura mudou a disponibilidade de pasto? a. Não mudou nada b. É o principal volumoso de inverno c. Aumentou muito a capacidade de suporte do inverno d. Devido a sobressemeadura tem mais pasto no inverno que no verão e. Quase eliminou o uso de silagem no inverno f. Viabilizou a produção de leite g Eliminou o uso de silagem no inverno h.. Diminuiu a utilização de concentrado Observação:Considerar mais de uma alternativa.
70. Desde Quando o senhor (a) faz sobressemeadura?
71 Houve mudança no efeito das secas na pastagem após a divisão? a. O solo ficou mais seco b. Não houve mudança c. o solo ficou mais úmido d. NSRp

72. Usa calcário no pasto? N ( ) S ( ) // dolomítico ( ) outro (_________) // Quanto? __________ Como decide usar?
73. Usa fertilizante no plantio piquetes (qdo houver)? N ( ) S ( ) /// formula (________) orgânico (_________) Quanto? _____ Como decide usar?
74. Usa fertilizante no CAMPO NATURALIZADO? N ( ) S ( ) /// formula (________) orgânico (________) Quanto? Como decide usar?
75. Faz cobertura? N ( ) S ( ) /// formula (________) orgânico (_________) Freq:______
76. Usa herbicidas? químicos ( ) ou orgânicos ( ) N usa ( ) /// Principal combate: _________ Freq.:
77. Usa inseticidas? químicos ( ) ou orgânicos ( ) N usa ( ) /// Principal combate: _________ Freq.:
78. Quantos piquetes sua propriedade possui:
79. Qual o tamanho médio dos piquetes?
80. Há presença de leguminosas em algum piquete? Quais? a.Trevo b.Amendoin forrageiro c.pega-pega d.cornichão e.Maku f.
81. Que gramas o senhor(a) tem no piquete? a. Missioneira_________________ b. Brachiaria: ______________________ c.Mombaça d. Angolinha e. Estrela africana (encrenca de vizinho) f. Tifiton g. Cameron h. Azevém i. Aveia j. Outros:

IX – ASPECTOS SANITÁRIOS DO REBANHO

82. O que aconteceu com a ocorrência de carrapatos? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Não houve mais ocorrências g.Ocorrência desprezíveis h. NSRp
83. Quais produtos ERAM/são utilizados para controle de carrapatos?
84. O que aconteceu com a ocorrência de mosca-do-chifre? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Não houve mais ocorrências g.Ocorrência desprezíveis h. NSRp
85. Quais produtos ERAM/são utilizados para controle da mosca-dos-chifres?
86. O que aconteceu com a ocorrência de verminoses? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Não houve mais ocorrências g.Ocorrência desprezíveis h. NSRp.
87. Quais produtos ERAM/são utilizados para controle de verminoses?
88. O que aconteceu com a ocorrência de mastites? a.Aumentou b.Aumentou um pouco c.Aumentou muito d.Manteve-se constante e.Diminuiu f.Diminuiu pouco g.Diminuiu muito h Média antes___________cab. i. Média agora___________cab.
89. Quais produtos ERAM/são utilizados para controle das mastites?
90. Utiliza o teste da caneca de fundo preto? a.Sim b.Às vezes c.Não e.NSRp.
91. De uma maneira geral, o que aconteceu com a ocorrência de outros problemas sanitários no seu rebanho? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.NSRp.
92. A quantidade de esterco na sala de ordenha e/ou na sala de espera mudou após a implantação do Pastoreio Voisin? Quanto? a. Aumentou b. Continuou a mesma quantidade c. Diminuiu d. NSRp
93. Com que freqüência a sala de ordenha ERA limpa? a. Todos os dias b. A cada 2 dias c. A cada 3 dias d. Uma vez por semana e. Outros:
94. Com que freqüência a sala de ordenha É limpa? a. Todos os dias b. A cada 2 dias c. A cada 3 dias d. Uma vez por semana e. Outros:
95. O que ERA feito com estes resíduos (esterco, água, etc.)? a. Era descartado na propriedade b. Era vendido c.Era colocado na esterqueira d. Escorria para os mananciais e. Colocado na pastagem f. Na lavoura g. NSRp.
96. O que É feito com estes resíduos (esterco, água, etc.)? a. É descartado na propriedade b. É vendido c. É colocado na esterqueira d. Escorria para os mananciais e. Colocado na pastagem f. Na lavoura g. NSRp.
97. O tempo de degradação (permanência no pasto) das bostas mudou? a. Continuou o mesmo tempo b. É menor c. É muito menor d. É maior e. É muito maior f. NSRp.
98. Se mudou, quanto em média? a. 1 rotação b. 2 rotações c. 3 rotações Dias:

X – CONSIDERAÇÕES ECONÔMICAS

99. O que o(a) senhor(a) achou sobre o investimento necessário para a adoção do Pastoreio Voisin? a. Alto; b.Muito alto c.Razoável d.Baixo e.Muito baixo f. alto mas valeu a pena.
100. Os recursos foram: a. recursos próprios b.financ. pelo Lat c. Pelo PRONAF d.Financ. Agropec. f.Financ. combinado:
101. O investimento realizado está proporcionando o retorno esperado? a. Sim b. Não c. mais que o esperado.
102. Em quanto tempo o Sr pagou o investimento feito para implantar o projeto? a. Paguei em _______anos b.Pagarei em __________anos c. NSRp.
103. A adoção do Pastoreio Voisin proporcionou melhoria da qualidade de vida do(a) senhor(a) e da sua família? a.Melhorou bastante b.Melhorou um pouco c.Ficou como antes d.Piorou um pouco e.Piorou bastante f. NSRp.
104. O senhor recomendaria a adoção do Pastoreio Voisin para outro produtor? a.Sim b.Não c. .Talvez

XI – SERVIÇOS ECOSSISTÊMICOS - SE / MANEJO E UTILIZAÇÃO DE INSUMOS

105. Era realizada adubação nas áreas de pastagens? a. Sim, em toda a área b. Sim, em parte da área c. Não d. NSRp.
106. Quais adubos? a. Químico b. Orgânico c. NSRp.
107. Atualmente é realizada a adubação das áreas de pastagens? a. Sim, em toda a área b. Sim, em parte da área c. Não d. NSRp.
108. Quais adubos? a. Químico b. Orgânico c. NSRp.
109. Mudou a <u>produção</u> do campo naturalizado após o projeto? a. Não mudou b. Mais produtivo c. Muito mais produtivo d. Menos produtivo
110. Mudou a <u>utilização das áreas</u> de campo naturalizado após o projeto? a. Não mudou b. Utilizo mais áreas c. Passou a ser a principal pastagem d. Passou a ser o principal pastagem e o principal volumoso e. Após o projeto só uso campo naturalizado e concentrado f. Uso muita pastagem anual g. Após o projeto uso mais pastagens anuais

XII - SERVIÇOS ECOSSISTÊMICOS - SE

111. Houve alguma mudança na aparência da água açudes e lagoas? a. Não houve b. Sim, melhorou c. Sim, piorou d Algumas melhoraram e Algumas pioraram f. NSRp.
112. Havia voçorocas/ravinas na pastagem? a. Sim b. Não c. NSRp. 113. Se sim, Quantas?
114. Houve alguma mudança nas voçorocas/ravinas da propriedade? a. Estão estabilizando c. Aumentou o número de voçorocas/ravinas b. Estão piorando d. Diminuiu o numero de voçorocas/ravinas e. NSRp
115. Foi usado algum método para controle da erosão? a. Sim b. Não e. NSRp. 116. Qual?
117. Com que freqüência era feita a renovação das pastagens (aração/gradagem...)? a. Não era feita b. Menos de 1 ano c. Todo ano d. A cada 2 anos e. A cada 3 anos ou mais f. Nunca fez a renovação g. NSRp
118. Com que freqüência é feita a renovação das pastagens (aração, gradagem...)? a. Não é e nem será feita b. Todo ano c. A cada 2 anos d. A cada 3 anos ou mais e. Pretende fazer f. NSRp.
119. Com que freqüência a área de pastagem ERA queimada? a. Todo ano b. A cada 2 anos c. A cada 3 anos ou mais d. Não era realizada a queima.
120. Com que freqüência É realizada a queimada na pastagem? a. Todo ano b. A cada 2 anos c. A cada 3 anos ou mais d. Não é realizada a queima e. NSRp.
121. Era e É observado pequenos animais, como minhoca ou besouro, nas pastagens? Era a. Sim b. Não c. NSRp É a. Sim b. Não c. NSRp 122. Quais? Era: É:
123. Havia algum tipo de preservação dos remanescentes florestais e mananciais? a. Sim b. Não c. NSRp 124. Que tipo?
125. É feito algum tipo de preservação dos remanescentes florestais e mananciais? a. Sim b. Não c. NSRp 126. Que tipo?

127. - Como era a cobertura do solo das pastagens? a. O solo era na maioria bem coberto b. O solo tinha áreas com pouca cobertura c. O solo era totalmente coberto d. O solo era desprotegido
128. Como é a cobertura do solo das pastagens? a. O solo é na maioria bem coberto b. O solo tem áreas com pouca cobertura c. O solo é totalmente coberto d. O solo é desprotegido

XIII - PERCEPÇÃO DOS VAISONISTAS SOBRE OS SE ASSOCIADOS ÀS FORMAÇÕES FLORESTAIS

129. Percebe algum benefício gerado pela presença da floresta na sua propriedade? a. Sim b. Não			
130. Se sim, quais?			
Disponibilidade hídrica (quantidade de água disponível)		Provisão de lenha	
Qualidade hídrica (qualidade da água)		Provisão de frutos, sementes e outros itens comestíveis	
Contenção da erosão do solo		Provisão de polinizadores	
Manutenção da qualidade do solo		Manutenção da biodiversidade	
Controle de pragas		Regulação da temperatura (microclima local)	
Disponibilidade de caça		Sombra para animais	
Provisão de madeira		Outros:	
131. Pensando nos produtos que existem na floresta, quais deles o Senhor (a) e a sua família utilizam?			
Madeira		Folhas (erva-mate, outros)	
Lenha		Abrigo para polinizadores	
Frutos		Água para dessedentação animal	
Óleo		Água para consumo humano	
Sementes		Outros	

XIV - AVALIAÇÃO DA DISPOSIÇÃO A PARTICIPAR DE UM PROGRAMA DE PSE

132. O senhor teria interesse em participar de um programa de pagamento por áreas de floresta em pé? a. Definitivamente não b. Provavelmente não c. Não tenho certeza d. Provavelmente sim e. Definitivamente sim
133. Qual o valor mínimo que o senhor estaria disposto a receber (R$/hectare/ano) para preservar a área mata na sua propriedade? a. 80 b. 100 c. 150 d. 200 e. 250 f. 300 g. 350 h. 400 i. 450 j. 500 l. 550 m. Outro:
134. Quantos hectares da propriedade o Senhor (a) estaria disposto a deixar para preservação das florestas nativas, caso recebesse incentivos econômicos para isso?
135. Caso o Senhor (a) fosse convidado para participar deste programa, só que dessa vez para recuperar áreas de floresta na sua propriedade, ou seja, além das áreas de floresta que o senhor já tem, o senhor receberia para aumentar áreas de floresta. O Senhor (a) estaria disposto a participar desse programa? a. Definitivamente não b. Provavelmente não c. Não tenho certeza d. Provavelmente sim e. Definitivamente sim
136. Caso o Senhor (a) tenha interesse em receber incentivos econômicos para recuperar áreas de floresta na sua propriedade, qual seria o valor mínimo que o Senhor (a) estaria disposto a receber por hectares/ano? a. 80 b. 100 c. 150 d. 200 e. 250 f. 300 g. 350 h. 400 i. 450 j. 500 l. 550 m. Outro:
137. Quantos hectares da propriedade o Senhor (a) estaria disposto a deixar para recuperar em áreas de floresta, caso recebesse incentivos econômicos para isso?

XV - LEGISLAÇÃO AMBIENTAL / MATA CILIAR

138. Sabe o que é mata ciliar? a. Sim b. Não obs.: “as florestas e demais formas de vegetação situadas ao longo dos rios ou de qualquer curso d’água.” 139. respondeu: a. correto b. parcialmente correto c incorreto
140. Há mata ciliar em sua propriedade? a. Sim b. Não 141. Ela está protegida? a. Não b. Está, mas não conforme a lei c. Está conforme a lei d. Dimensão:
142. Sabe quais as funções da MC? a. Não b. Sim 143. Qual é? a. preservar águas b. paisagem c. biodiversidade d. alimentar os peixes e. fluxo de animais f. seqüestro de Carbono g. controle da erosão. Obs.: Aceitar mais de uma alternativa.

144. Possui algum rio ou algum outro curso d`água na propriedade? a. Sim b. Não
145. Se houver rio/córrego na propriedade, os animais usam este(s) como fonte de água para consumo? a. Sim b. Não c. Não há rio/córrego/manancial 146. Nome do rio/córrego:
147. Se possui rio na propriedade, o rio mudou de largura e profundidade nos últimos 10 anos? a. igual b. + largo c. + profundo d. - largo d. – profundo 148. Qual a provável causa?
149. Se há rios ou riachos, houve alguma mudança na erosão das margens dos rios e riachos nos últimos 10 anos? a. Sim, diminuiu a erosão b. Sim, aumentou a erosão c. Não houve mudança d. NSR
150. Se há presença de riacho, houve alguma mudança na aparência da água dos riachos nos últimos 10 anos? a. Ficou mais escura b. Ficou com cor c. Variação na transparência d. Não houve e. NSRp
151. A qualidade da água melhorou ou piorou nos últimos 10 anos? a. melhorou b. piorou c. se mantém igual
152. Houve alguma mudança na quantidade de peixes nos riachos nos últimos 10 anos? a. Diminuiu b. Diminuiu muito c. Acabou d. Não houve mudança e. NSRp
153. Sabe quanto a lei exige de Mata Ciliar para cada lado dos rios? a. sim, 30 metros para cursos d`água ≤10 m b. Não. (*Explicar: 30 m p/ ≤ 10 m)*
154. Concorda com o limite imposto pela lei? a.Não b. Mais ou menos c. Sim Por quê?
155. Caso não consiga atender os limites da lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

XVI - LEGISLAÇÃO AMBIENTAL/ PROTEÇÃO DE NASCENTES

156. Possui alguma nascente ou olho d`água na propriedade? a. Sim b.Não
157. Está protegido? a. Não b. Está, mas não conforme a lei c. Está conforme a lei d. Dimensão:
158. Houve alguma mudança na quantidade da água dos mananciais nos últimos 10 anos? a. Aumentou b. Aumentou muito c. Diminuiu d Diminuiu muito e. Não houve mudança.
159. Houve alguma mudança na qualidade da água da sua fonte nos últimos 10 anos? a. Não b. Sim, ficou com cor c. Sim, perdeu a cor d. Sim, perdeu o gosto e. Sim, ficou com gosto f. Sim, ficou com cor e perdeu o gosto g. Sim, ficou com cor e com gosto h. Sim, perdeu a cor e ficou com gosto
160. Sabe qual e a exigência da lei com relação à preservação do entorno das nascentes? a. não b. sim Obs.: “um raio mínimo de 50 metros nas áreas de entorno das nascentes” 158. Respondeu: a. correto b. parcialmente correto c incorreto
161. Concorda com o limite imposto pela lei? a.Não b. Mais ou menos c. Sim Por quê?
162. Caso não consiga atender os limites da lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

XVII- LEGISLAÇÃO AMBIENTAL/ PROTEÇÃO DE ÁREAS COM ALTA DECLIVIDADE

163. Possui alguma área com declividade superior a 45° na propriedade? a. Sim b.Não
164. Essas encostas estão sendo utilizadas? a. sim b. sim, algumas (____) c. sim, todas (____) d. não
165. Sabe que é preciso preservar áreas com declividade superior a 45° na propriedade? a. não b. sim
166. Concorda com a exigência da lei? a.Não b. Mais ou menos c. Sim Por quê?
167. Caso não consiga atender a lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

XVIII - LEGISLAÇÃO AMBIENTAL/ APPS

168. Sabe o que significa o termo APP? a. não b. sim Obs.: “Área de Preservação Permanente” 169. Respondeu: a. correto b. parcialmente correto c incorreto
170. Em sua opinião, quais áreas são APP? *Não sugerir. Marcar as respostas citadas pelo agricultor*

a. Mata Ciliar b. Áreas declivosas c. Proteção de nascentes d.. Topos de morros e. Restingas f. Ao redor de lagoas g. Nas bordas dos tabuleiros e chapadas h. Em altitudes acima de 1.800 m i. Outras

XIX - LEGISLAÇÃO AMBIENTAL/ RESERVA LEGAL

171. Sabe o que é Área de Reserva Legal? a. não b. sim Obs.: "É o percentual de área que deve ser conservada na propriedade rural com vegetação nativa." 172. Respondeu: a. correto b. parcialmente correto c incorreto
173. Sabe qual é a exigência da lei com relação à Reserva Legal? a. não b. sim Obs.: "20% da área total da propriedade rural" 174. Respondeu: a. correto b. parcialmente correto c incorreto
175. Concorda com o limite imposto pela lei? a.Não b. Mais ou menos c. Sim Por quê?
176. Caso não consiga atendar a lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

ATTACHMENT B – Questionnaire Applied to Non- MIG Farmers

Diagnóstico Conjunto - Caracterização da propriedade e Percepção do produtor sobre a implantação do Pastoreio Voisin, Serviços Ambientais, Legislação Ambiental, Produção Orgânica e Pagamento por Serviços Ecossistêmico.

Realização: PROCAM (USP), UFSC, GPVoisin, GUND (UVM) e CiVi.net

I – IDENTIFICAÇÃO

Entrevistadores:	Data:	
1. Nome:	2. Data de nascimento:	
3. Nome do esposo (a):	4. Data de nascimento:	
5. Comunidade:	6. Município:	
7. Microbacia:	8. Telefone:	
9. Projeto do Laticínio:	10. Área total da propriedade:	
11.Georreferenciamento (WGS84): Lat____________________________ Long____________________________		

II – CARACTERIZAÇÃO FAMILIAR, DO TRABALHO E DE GÊNERO

12. Quantas são, qual a idade e gênero das pessoas que compõem a família?

Gênero	Até 10 anos	11 a 20 anos	21 a 30 anos	31 a 40 anos	41 a 50 anos	51 a 60 anos	61 ou mais
Feminino							
Masculino							

13. Algum membro da família tem alguma atividade econômica fora da propriedade? a. Sim b. Não
14. Quantos membros da família trabalham exclusivamente na propriedade?
15. Quantos membros da família trabalham parte do dia na propriedade?
16. Vocês contratam pessoas para trabalhar na propriedade? a. Sim b. Não 17. Quais os meses? ☐ Jan. ☐ Fev. ☐ Març. ☐ Abril. ☐ Maio. ☐ Junh. ☐ Julh. ☐ Agos. ☐ Set. ☐ Out. ☐ Nov. Dez.
18. Quantos membros da família têm alguma fonte de renda que não seja decorrente da atividade na propriedade (incluindo pensionistas)?
19. Quantos membros da família estão morando fora da propriedade? 20. Qual o motivo? a. Estudar b. Trabalhar c. Melhorar condição de renda d. Vontade e Outro:

III – GESTÃO E CARACTERIZAÇÃO ZOOTECNICA

23. Interesse econômico: a. Bovinocultura de leite b. Outro interesse:
24. Composição racial: a. Holandês b. Jersey c. Pardo-Suiço d. Gir Leiteiro e. Girolando f. Gado Mistiço g. SRD.
23. O senhor(a) participa de alguma associação de criação de animais?Qual?
24. O (a) senhor(a) faz controle contábil da atividade leiteira? a. Sim, contador b Não faço c. Sim, participo do CONTAGRI da Epagri d. Sim, utilizo software específico e. Sim, utilizo caderno de anotações
25. O(a) senhor(a) faz controle leiteiro? a. Sim, diário b. Sim, semanalmente c. Sim, quinzenalmente d. Sim, mensalmente e. Outro: _______________ f. De vez em quando g. Não h. NSRP Obs: Entregar um modelo
26. Desde quando você produz leite?

Item	Unidades físicas	Observações
30.Área efetiva		Soma das áreas utilizadas para a criação animal.

31.Produção TOTAL de leite l/dia		
32.Composição do rebanho		
c. Vacas		
d. Novilhas		

IV – ASSISTÊNCIA TÉCNICA

30. Quem presta assistência técnica para a sua propriedade? a.Epagri b.GPVoisin c.Cooperativa d.Prefeitura e. Laticínio f. ONG g. Empresa contratada h. Agropecuária i. NDA j. NSRp
31. Como é a qualidade da assistência técnica realizada? a.Muito boa b.Boa c.Razoável d.Ruim e. Muito ruim f. Não recebo assistência técnica g. NSRp
32. A sua propriedade recebe assistência médico-veterinária? a.Sim b.Não c.Empresa:
33. Como é a qualidade da assistência médico-veterinária recebida? a. Muito boa b.Boa c. Razoável d.Ruim Muito ruim e. Não recebo assistência médico veterinária f. NSRp

V – QUANTO À PRODUÇÃO ORGÂNICA

34. O(a) senhor(a) sabe o que significa produto orgânico? a.Sim b.Não c.Acho que sim d.Nao tenho certeza			
35. Produz leite orgânico (ou agroecológico)? a.Sim b.Não, mas tenho interesse em produzir c.Não, não tenho interesse d.Acho que deve ser muito caro e.Acho que deve ser difícil f. NSRp			
36. Se produz de forma orgânica, que instituição certifica a produção? a.IBD b.Ecocert c.Rede Ecovida d. A produção não é certificada e.Estou em transição com a certificadora:____________________ f.NSRp			
37. Há quanto tempo o senhor produz leite orgânico?			
38. O(a) senhor(a) sabe o que é homeopatia? a. Sim b.Acho que sim c. Não d. não tenho clareza			
39. O(a) senhor(a) sabe o que é fitoterapia? a. Sim b.Acho que sim c. Não d. não tenho clareza			
40. O(a) senhor(a) utiliza em seu rebanho medicamentos homeopáticos e fitoterápicos?			
41.	Medicamentos fitoterápicos.	Medicamentos homeopáticos	Medicamentos convencionais.
42. Há quanto tempo utiliza fitoterápicos e homeopaticos? Fitoterápicos: homeopáticos:			
43. Acha que estes produtos são confiáveis? a.não b.sim c.talvez d. NSRp.			

VI – QUANTO A PRODUÇÃO DE LEITE, PASTAGEM, COMPORTAMENTO E ALIMENTAÇÃO

44. O seu rebanho tem aumentado nestes últimos 10 anos? a. Sim b. Não c. NSRp
45. A produtividade de leite por animal na sua propriedade tem aumentado nos últimos 10 anos? a. Sim, aumentou b. Sim, aumentou bastante c.Manteve-se constante d.Não, diminuiu e. Não, diminuiu bastante f. NSRp
46. A produção diária de leite tem aumentado em sua propriedade nos últimos 10 anos? a. Sim, aumentou bastante b.Sim, aumentou c.Manteve-se constante d.Não, diminuiu e. Não, diminuiu bastante f. NSRp.
47. A carga de trabalho diária em sua propriedade tem mudado nestes últimos 10 anos? a.Aumentou b.Aumentou muito c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Igual mas é menos penosa f.NSRp.
48. Você tem percebido alguma alteração no comportamento dos animais nestes últimos 10 anos? a. Igual b.Ficaram mais dóceis c. Ficaram mais contentes d.Ficaram mais difíceis de lidar e. NSRp.
49. Você tem percebido alguma mudança com a pastagem nestes últimos 10 anos? a.piorou b.melhorou a qualidade f. não mudou c. aumentou a quantidade d. aumentou muito a qualidade e quantidade e.diminuiu muito a qualidade e quantidade.

50. Se o senhor (a) faz sobressemeadura, desde quando o faz?
51. Caso o senhor faça sobre semeadura, a sobressemeadura tem mudado a disponibilidade de pasto? a. Não mudou nada b. É o principal volumoso de inverno c. Aumentou muito a capacidade de suporte do inverno

d. Devido a sobressemeadura tem mais pasto no inverno que no verão e. Quase eliminou o uso de silagem no inverno f. Viabilizou a produção de leite g. Eliminou o uso de silagem no inverno h.. Diminuiu a utilização de concentrado Observação:Considerar mais de uma alternativa.
52. Há presença de leguminosas na pastagem? Quais? a.Trevo b.Amendoin forrageiro c.pega-pega d.cornichão e.Maku f.
53. Que gramas o senhor(a) tem no pasto? a. Missioneira_________________ b. Brachiaria: ______________________ c.Mombaça d. Angolinha e. Estrela africana (encrenca de vizinho) f. Tifiton g. Cameron h. Azevém i. Aveia j. Outros:

VI– ASPECTOS SANITÁRIOS DO REBANHO

54. O que tem acontecido com a ocorrência de carrapatos nos últimos 10 anos? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Não houve mais ocorrências g.Ocorrência desprezíveis h. NSRp
55. Quais produtos ERAM/são utilizados para controle de carrapatos?
56. O que tem acontecido com a ocorrência de mosca-do-chifre nos últimos 10 anos? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Não houve mais ocorrências g.Ocorrência desprezíveis h. NSRp
57. Quais produtos ERAM/são utilizados para controle da mosca-dos-chifres?
58. O que tem acontecido com a ocorrência de verminoses nos últimos 10 anos? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.Não houve mais ocorrências g.Ocorrência desprezíveis h. NSRp.
59. Quais produtos ERAM/são utilizados para controle de verminoses?
60. O que tem acontecido com a ocorrência de mastites nos últimos 10 anos? a.Aumentou b.Aumentou um pouco c.Aumentou muito d.Manteve-se constante e.Diminuiu f.Diminuiu pouco g.Diminuiu muito h Média antes___________cab. i. Média agora___________cab.
61. Quais produtos ERAM/são utilizados para controle das mastites?
62. Utiliza o teste da caneca de fundo preto? a.Sim b.Às vezes c.Não e.NSRp.
63. De uma maneira geral, o que tem acontecido com a ocorrência de outros problemas sanitários no seu rebanho? a.Aumentou muito b.Aumentou c.Manteve-se constante d.Diminuiu e.Diminuiu muito f.NSRp.
64. Com que freqüência a sala de ordenha É limpa? a. Todos os dias b. A cada 2 dias c. A cada 3 dias d. Uma vez por semana e. Outros:
65. O que É feito com estes resíduos (esterco, água, etc.)? a. É descartado na propriedade b. É vendido c. É colocado na esterqueira d. Escorria para os mananciais e. Colocado na pastagem f. Na lavoura g. NSRp.
66. Qual o tempo médio de degradação (permanência no pasto) das bostas? a. 1 rotação b. 2 rotações c. 3 rotações Dias:

VIII – SERVIÇOS ECOSSISTÊMICOS - SE / MANEJO E UTILIZAÇÃO DE INSUMOS

67. É realizada a adubação das áreas de pastagens? a. Sim, em toda a área b. Sim, em parte da área c. Não d. NSRp.
68. Quais adubos? a. Químico b. Orgânico c. NSRp.

IX - SERVIÇOS ECOSSISTÊMICOS - SE

69. O senhor (a) tem percebido alguma mudança na aparência da água açudes e lagoas nos últimos 10 anos? a. Não houve b. Sim, melhorou c. Sim, piorou d Algumas melhoraram e Algumas pioraram f. NSRp.
70. Há 10 anos havia voçorocas/ravinas na pastagem? a. Sim b. Não c. NSRp. 71. Se sim, Quantas?

72. Houve alguma mudança nas voçorocas/ravinas da propriedade nos últimos 10 anos? a. Estão estabilizando c. Aumentou o número de voçorocas/ravinas b. Estão piorando d. Diminuiu o numero de voçorocas/ravinas e. NSRp
73. Foi usado algum método para controle da erosão? a. Sim b. Não e. NSRp. 74. Qual?
75. Com que freqüência É realizada a queimada na pastagem? a. Todo ano b. A cada 2 anos c. A cada 3 anos ou mais d. Não é realizada a queima e. NSRp.
76. O senhor (a) tem percebido alguma mudança na presença de pequenos animais, como minhoca ou besouro, nas pastagens? a. Sim b. Não c. NSRp 77. Quais?
78. É feito algum tipo de preservação dos remanescentes florestais e mananciais? a. Sim b. Não c. NSRp 79. Que tipo?
80. Como é a cobertura do solo das pastagens? a. O solo é na maioria bem coberto b. O solo tem áreas com pouca cobertura c. O solo é totalmente coberto d. O solo é desprotegido

X - PERCEPÇÃO SOBRE OS SE ASSOCIADOS ÀS FORMAÇÕES FLORESTAIS

81. Percebe algum benefício gerado pela presença da floresta na sua propriedade? a. Sim b. Não			
82. Se sim, quais?			
Disponibilidade hídrica (quantidade de água disponível)		Provisão de lenha	
Qualidade hídrica (qualidade da água)		Provisão de frutos, sementes e outros itens comestíveis	
Contenção da erosão do solo		Provisão de polinizadores	
Manutenção da qualidade do solo		Manutenção da biodiversidade	
Controle de pragas		Regulação da temperatura (microclima local)	
Disponibilidade de caça		Sombra para animais	
Provisão de madeira		Outros:	
83. Pensando nos produtos que existem na floresta, quais deles o Senhor (a) e a sua família utilizam?			
Madeira		Folhas (erva-mate, outros)	
Lenha		Abrigo para polinizadores	
Frutos		Água para dessedentação animal	
Óleo		Água para consumo humano	
Sementes		Outros	

XI - AVALIAÇÃO DA DISPOSIÇÃO A PARTICIPAR DE UM PROGRAMA DE PSE

84. O senhor teria interesse em participar de um programa de pagamento por áreas de floresta em pé? a. Definitivamente não b. Provavelmente não c. Não tenho certeza d. Provavelmente sim e. Definitivamente sim
85. Qual o valor mínimo que o senhor estaria disposto a receber (R$/hectare/ano) para preservar a área mata na sua propriedade? a. 80 b. 100 c. 150 d. 200 e. 250 f. 300 g. 350 h. 400 i. 450 j. 500 l. 550 m. Outro:
86. Quantos hectares da propriedade o Senhor (a) estaria disposto a deixar para preservação das florestas nativas, caso recebesse incentivos econômicos para isso?
87. Caso o Senhor (a) fosse convidado para participar deste programa, só que dessa vez para recuperar áreas de floresta na sua propriedade, ou seja, além das áreas de floresta que o senhor já tem, o senhor receberia para aumentar áreas de floresta. O Senhor (a) estaria disposto a participar desse programa? a. Definitivamente não b. Provavelmente não c. Não tenho certeza d. Provavelmente sim e. Definitivamente sim
88. Caso o Senhor (a) tenha interesse em receber incentivos econômicos para recuperar áreas de floresta na sua propriedade, qual seria o valor mínimo que o Senhor (a) estaria disposto a receber por hectares/ano? a. 80 b.

100 c. 150 d. 200 e. 250 f. 300 g. 350 h. 400 i. 450 j. 500 l. 550 m. Outro:
89. Quantos hectares da propriedade o Senhor (a) estaria disposto a deixar para recuperar em áreas de floresta, caso recebesse incentivos econômicos para isso?

X – SOBRE O PROJETO DE PASTOREIO VOISIN

90. O senhor (a) já ouviu falar sobre o Projeto de Pastoreio Voisin? ? a. sim b. não c.NSRp.
91. Se sim, como o(a) senhor(a) ficou sabendo do Pastoreio Voisin? a. Televisão, jornal; b. Extensionista da Epagri; c.Técnico da prefeitura; e. Técnico do laticínio; f. GPVoisin; g. Algum conhecido; h. não soube responder.
92. O senhor (a) acredita que este projeto poderia trazer tanto melhorias ambientais quanto ganhos econômicos para sua propriedade? a.Sim b.Acredito fortemente c.Não acredito c.Tenho dúvida d. NSRp
93. O senhor (a) já pensou em adotar o projeto de Pastoreio Voisin? a.Sim b.Não
94. Quais as razões de você não adotar o Pastoreio Voisin? a.Não sei como fazer para adotar. b. É muito caro e não tenho dinheiro para adotar. c. Estou satisfeito com o sistema que utilizo. d. NSRp.
95. O senhor (a) adotaria o Sistema de Pastoreio Voisin caso tivesse certeza que este sistema aumentaria seus ganhos financeiros e reduziria seus custos? a.Sim b.Não. c. Talvez
96. Se o senhor (a) pudesse obter um empréstimo a uma taxa de juros baixa (Ex.: igual a inflação), isto o tornaria mais interessado em adotar o Sistema de Pastoreio Voisin? a.Sim b.Não.c. Talvez
97. Se o senhor (a) pudesse obter um empréstimo no qual a taxa de juros cobrada estivesse vinculada aos seus rendimentos, ou seja, se fosse cobrado de acordo com o que você pudesse pagar, isto o tornaria mais interessado em adotar o Sistema de Pastoreio Voisin? a.Sim b.Não.c. Talvez
98. O senhor(a) adotaria o Sistema de Pastoreio Voisin caso você recebesse o dinheiro que cobrisse todos os gastos com a sua implementação? a.Sim b.Não.c. Talvez
99. O que o senhor (a) acha sobre a dificuldade de implantar o projeto de Pastoreio Voisin? a.Muito difícil b.Difícil c.Razoável d.Fácil e. Muito fácil f. NSRp.
100. O senhor(a) gostaria de receber alguém na sua casa para lhe falar sobre o projeto de Pastoreio Voisin, como implementá-lo e seus benefícios? a.Sim b.Não c. Talvez

XI - LEGISLAÇÃO AMBIENTAL / MATA CILIAR

101. Sabe o que é mata ciliar? a. Sim b.Não obs.: "as florestas e demais formas de vegetação situadas ao longo dos rios ou de qualquer curso d'água." 109. respondeu: a. correto b. parcialmente correto c incorreto
102. Há mata ciliar em sua propriedade? a. Sim b.Não 103. Ela está protegida? a. Não b. Está, mas não conforme a lei c. Está conforme a lei d. Dimensão:
104. Sabe quais as funções da MC? a. Não b. Sim 105. Qual é? a. preservar águas b. paisagem c.biodiversidade d. alimentar os peixes e. fluxo de animais f. seqüestro de Carbono g. controle da erosão. Obs.: Aceitar mais de uma alternativa.
106. Possui algum rio ou algum outro curso d\`água na propriedade? a. Sim b. Não
107. Se houver rio/córrego na propriedade, os animais usam este(s) como fonte de água para consumo? a. Sim b. Não c. Não há rio/córrego/manancial 108. Nome do rio/córrego:
109. Se possui rio na propriedade, o rio mudou de largura e profundidade nos últimos 10 anos? a. igual b. + largo c. + profundo d. - largo d. – profundo 110. Qual a provável causa?
111. Se há rios ou riachos, houve alguma mudança na erosão das margens dos rios e riachos nos últimos 10 anos? a. Sim, diminuiu a erosão b. Sim, aumentou a erosão c. Não houve mudança d. NSR
112. Se há presença de riacho, houve alguma mudança na aparência da água dos riachos nos últimos 10 anos? a. Ficou mais escura b. Ficou com cor c. Variação na transparência d. Não houve e. NSRp
113. A qualidade da água melhorou ou piorou nos últimos 10 anos? a. melhorou b. piorou c. se mantém igual

114. Houve alguma mudança na quantidade de peixes nos riachos nos últimos 10 anos? a. Diminuiu b. Diminuiu muito c. Acabou d. Não houve mudança e. NSRp
115. Sabe quanto a lei exige de Mata Ciliar para cada lado dos rios? a. sim, 30 metros para cursos d`água ≤10 m b. Não. (*Explicar: 30 m p/ ≤ 10 m)*
116. Concorda com o limite imposto pela lei? a.Não b. Mais ou menos c. Sim Por quê?
117. Caso não consiga atender os limites da lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

XII - LEGISLAÇÃO AMBIENTAL/ PROTEÇÃO DE NASCENTES

118. Possui alguma nascente ou olho d`água na propriedade? a. Sim b.Não
119. Está protegido? a. Não b. Está, mas não conforme a lei c. Está conforme a lei d. Dimensão:
120. Houve alguma mudança na quantidade da água dos mananciais nos últimos 10 anos? a. Aumentou b. Aumentou muito c. Diminuiu d Diminuiu muito e. Não houve mudança.
121. Houve alguma mudança na qualidade da água da sua fonte nos últimos 10 anos? a. Não b. Sim, ficou com cor c. Sim, perdeu a cor d. Sim, perdeu o gosto e. Sim, ficou com gosto f. Sim, ficou com cor e perdeu o gosto g. Sim, ficou com cor e com gosto h. Sim, perdeu a cor e ficou com gosto
122. Sabe qual e a exigência da lei com relação à preservação do entorno das nascentes? a. não b. sim Obs.: "um raio mínimo de 50 metros nas áreas de entorno das nascentes" 123. Respondeu: a. correto b. parcialmente correto c incorreto
124. Concorda com o limite imposto pela lei? a.Não b. Mais ou menos c. Sim Por quê?
125. Caso não consiga atender os limites da lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

XIII- LEGISLAÇÃO AMBIENTAL/ PROTEÇÃO DE ÁREAS COM ALTA DECLIVIDADE

126. Possui alguma área com declividade superior a 45° na propriedade? a. Sim b.Não
127. Essas encostas estão sendo utilizadas? a. sim b. sim, algumas (____) c. sim, todas (____) d. não
128. Sabe que é preciso preservar áreas com declividade superior a 45° na propriedade? a. não b. sim
129. Concorda com a exigência da lei? a.Não b. Mais ou menos c. Sim Por quê?
130. Caso não consiga atender os limites da lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

XIV - LEGISLAÇÃO AMBIENTAL/ APPS

131. Sabe o que significa o termo APP? a. não b. sim Obs.: "Área de Preservação Permanente" 132. Respondeu: a. correto b. parcialmente correto c incorreto
133. Em sua opinião, quais áreas são APP? <u>Não sugerir</u>. *Marcar as respostas citadas pelo agricultor* a. Mata Ciliar b. Áreas declivosas c. Proteção de nascentes d.. Topos de morros e. Restingas f. Ao redor de lagoas g. Nas bordas dos tabuleiros e chapadas h. Em altitudes acima de 1.800 m i. Outras

XV- LEGISLAÇÃO AMBIENTAL/ RESERVA LEGAL

134. Sabe o que é Área de Reserva Legal? a. não b. sim Obs.: "É o percentual de área que deve ser conservada na propriedade rural com vegetação nativa." 135. Respondeu: a. correto b. parcialmente correto c incorreto
136. Sabe qual e a exigência da lei com relação à Reserva Legal? a. não b. sim Obs.: "20% da área total da propriedade rural" 137. Respondeu: a. correto b. parcialmente correto c incorreto
138. Concorda com o limite imposto pela lei? a.Não b. Mais ou menos c. Sim Por quê?
139. Caso não consiga atender os limites da lei, estaria disposta a atender caso recebesse uma quantia por isso? a.Não b. Sim c. Talvez

ATTACHMENT C – Dairy Production Costs Spreadsheet Used in the Accounting Project

PROJETO AGROECOLOGIA E PAGAMENTO DE SERVIÇOS ECOSSISTÊMICOS – UVM/ UFSC/USP
LABORATÓRIO DE SISTEMAS SILVIPASTORIS - GRUPO DE PASTOREIO VOISIN GPVOISIN UFSC
LABORATÓRIO DE GOVERNANÇA AMBIENTAL (GOVAMB) - UNIVERSIDADE DE SÃO PAULO (USP)

PLANILHA DE CUSTO DE PRODUÇÃO DA ATIVIDADE LEITEIRA	
Produtor:	Referente ao mês de:
Comunidade:	Município:
Responsável pelo preenchimento:	Data de entrega da planilha: ____/____/____

1. CUSTO VARIÁVEL				
1.1 ALIMENTAÇÃO ANIMAL				
DISCRIMINAÇÃO	**QUANTIDADE (Kg)**	**ADQUIRIDO (marcar)**	**PRODUZIDO (marcar)**	**Preço pago por unidade**
a) Ração ____________		☐	☐	
b)Farelo de Trigo		☐	☐	
c)Farelo de Soja		☐	☐	
d)Minerais		☐	☐	
e)Capineira		☐	☐	
1.		☐	☐	
2.		☐	☐	
f) Silagem de:		☐	☐	

☐ Milho	☐ Capim Elefante	Cana de açúcar ☐	☐ Outros:

1.2 ÁREA DE PASTO E DE INSUMO PARA ALIMENTAÇÃO ANIMAL				
1.2.1 SEMENTE ou MUDA				
DISCRIMINAÇÃO	**QUANTIDADE (Kg/unidade)**	**ADQUIRIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a)Aveia		☐	☐	
b)Azevém		☐	☐	
c) Trevo Branco		☐	☐	
d)Trevo Vermelho		☐	☐	
e) Missioneira		☐	☐	
f) Milho		☐	☐	
g)Cana de Açúcar		☐	☐	
h) Capim Elefante		☐	☐	
i) Outros:				
1.		☐	☐	
2.		☐	☐	

1.2.3 ADUBAÇÃO						
DISCRIMINAÇÃO	**COMPOSIÇÃO**	**QUANTIDADE (Kg)**	**ADQUIRIDO (marcar)**	**PRODUZIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**

a) 1. Adubo químico			☐	☐	☐	
2. Adubo químico			☐	☐	☐	
b) 1 .Adubo orgânico			☐	☐	☐	
2. Adubo orgânico			☐	☐	☐	
3. Adubo orgânico			☐	☐	☐	

1.2.4 CORREÇÃO DE SOLO					
DISCRIMINAÇÃO	**TIPO**	**QUANTIDADE (tonelada)**	**ADQUIRIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a) Calcário			☐	☐	
b) Outro			☐	☐	

1.2.5 DEFENSIVOS AGRÍCOLAS						
DISCRIMINAÇÃO	**TIPO**	**QUANTIDADE**	**ADQUIRIDO (marcar)**	**PRODUZIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a)1. Inseticida			☐	☐	☐	
2. Inseticida			☐	☐	☐	
b) 1.Herbicida			☐	☐	☐	
2. Herbicida			☐	☐	☐	
c)1.Fungicida			☐	☐	☐	
2. Fungicida			☐	☐	☐	

1.2.6 ANÁLISE DE SOLO				
DISCRIMINAÇÃO	**Número de análises feitas**	**ADQUIRIDO (marcar)**	**DOADO (marcar)**	**Preço pago por análise**
a) Análise de fertilidade				
b) Outro:				

1.3 SANIDADE ANIMAL							
1.3.1 MEDICAMENTO							
Combate	**Descrição**	**Quantidade**	**Nº de animais infectados**	**ADQUIRIDO (marcar)**	**PRODUZIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a) Verminose				☐	☐	☐	
b)Parasitas:							
1. Carrapato				☐	☐	☐	
2. Bicheira				☐	☐	☐	
3.Berne				☐	☐	☐	
4. Piolho				☐	☐	☐	
c)Mastite				☐	☐	☐	
d)Outro: 1.				☐	☐	☐	

1. 3.2 HIGIENIZAÇÃO			
FOCO	**PRODUTO**	**QUANTIDADE**	**Preço pago por unidade**
a) Animal			
b)Sala de ordenha e ordenhadeira			
c)Máquina de refrigeração de leite			
d) outro:			

1.4 INSEMINAÇÃO				
DESCRIMINAÇÃO	**QUANTIDADE**	**ADQUIRIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a) Sêmen		☐	☐	
b)Nitrogênio		☐	☐	

1.5 OUTROS				
DESCRIÇÃO	**QUANTIDADE**	**ADQUIRIDO (marcar)**	**ACESSO LIVRE (marcar)**	**Preço pago por unidade**
a) Energia		☐	☐	
b) Água		☐	☐	
c) Outros: 1.		☐	☐	
2.		☐	☐	
3.		☐	☐	

2. CUSTO FIXO						
2.1 MANUTENÇÃO (reposição de peças, uso de óleos, pintura, etc.)						
DISCRIMINAÇÃO	**TIPO**	**QUANTIDADE**	**ADQUIRIDO (marcar)**	**PRODUZIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a) Estábulos			☐	☐	☐	
b)Veículo			☐	☐	☐	
c)Trator			☐	☐	☐	
d)Ordenhadeira			☐	☐	☐	
e)Cercas			☐	☐	☐	
f) Outros:			☐	☐	☐	
1.			☐	☐	☐	
2.			☐	☐	☐	
3.			☐	☐	☐	

2.2 MAO-DE-OBRA				
FINALIDADE	FAMILIAR (marcar)	CONTRATADA (marcar)	Nª DE DIÁRIAS	VALOR DA DIÁRIA
a) Melhoramento de pastagem (anual ou perene)	☐	☐		
b)Colheita de volumoso	☐	☐		
c)Plantação de volumoso	☐	☐		
d) Silagem	☐	☐		
e) Manutenção de veículos	☐	☐		
f)Manutenção de trator	☐	☐		
g)Manutenção de ordenhadeira	☐	☐		
h)Manutenção de cercas	☐	☐		
i)Inseminação	☐	☐		
j) Manejo do gado	☐	☐		
l) Cuidados veterinários:	☐	☐		
1.	☐	☐		
2.	☐	☐		
3.	☐	☐		
m) Gradagem do solo	☐	☐		
n) Calagem do solo	☐	☐		
o) Fertilização do solo	☐	☐		
p)Aplicação de defensivos agrícolas	☐	☐		
q) Outros:	☐	☐		
1.	☐	☐		
2.	☐	☐		
3.	☐	☐		

2.3 COMBUSTÍVEL				
DISCRIMINAÇÃO	QUANTIDADE	ADQUIRIDO (marcar)	DOADO (marcar)	Preço pago por unidade
a) Gasolina		☐	☐	
b) Óleo diesel		☐	☐	
c) Gás				

2.3 ALUGUEL DE MÁQUINAS E EQUIPAMENTOS				
DISCRIMINAÇÃO	HORAS CONTRATADAS	ADQUIRIDO (marcar)	DOADO (marcar)	Preço pago por hora
a) Trator		☐	☐	
b) semeadora		☐	☐	
c)Arado		☐	☐	
d)Grade		☐	☐	
e)Colhedora		☐	☐	

f)Subsolador		☐	☐	
g) Outros:				
1.		☐	☐	
2.		☐	☐	
3.		☐	☐	

2.4 IMPOSTOS, TAXAS E SEGUROS				
DISCRIMINAÇÃO	**TIPO**	**PAGO (marcar)**	**ISENTO (marcar)**	**Preço pago**
a) IPVA		☐	☐	
b) Seguro		☐	☐	
c) Imposto da Terra		☐	☐	
d)Taxas diversas:		☐	☐	
1.		☐	☐	
2.		☐	☐	
3.		☐	☐	

3. OUTROS (custos não descritos na planilha)					
DISCRIMINAÇÃO	**QUANTIDADE**	**ADQUIRIDO (marcar)**	**PRODUZIDO (marcar)**	**DOADO (marcar)**	**Preço pago por unidade**
a)		☐	☐	☐	
b)		☐	☐	☐	
c)		☐	☐	☐	
d)		☐	☐	☐	
e)		☐	☐	☐	

ATTACHMENT D − Dairy Assets And Debts Spreadsheet Used in the Accounting Project

PROJETO AGROECOLOGIA E PAGAMENTO DE SERVIÇOS ECOSSISTÊMICOS – UVM/UFSC/ USP
LABORATÓRIO DE SISTEMAS SILVIPASTORIS - GRUPO DE PASTOREIO VOISIN GPVOISIN UFSC
LABORATÓRIO DE GOVERNANÇA AMBIENTAL (GOVAMB) - UNIVERSIDADE DE SÃO PAULO (USP)

BALANÇO DE BENS E OBRIGAÇÕES	
Produtor:	Referente ao mês de:
Comunidade:	Município:
Responsável pelo preenchimento:	Data de entrega da planilha: ______/______/________

1. ATIVOS							
01.1 BENS							
DESCREMINAÇÃO	**QUANTIDADE**	**VALOR ATUAL ESTIMADO**	**Herdado**	**Adquirido**			
				Financiado		**Recurso próprio**	
				Quitado	**Não quitado**		
a) Área de pasto			☐	☐	☐	☐	
b) Área de volumoso para alimentação animal			☐	☐	☐	☐	
c) Cerca: Comum ☐ elétrica	☐		☐	☐	☐	☐	
d) Bebedouro			☐	☐	☐	☐	
e) Ordenhadeira mecânica			☐	☐	☐	☐	
f) Automóvel			☐	☐	☐	☐	
g) Sala de ordenha: chão batido ☐ piso	☐		☐	☐	☐	☐	
h) Esterqueira			☐	☐	☐	☐	
i)Máquinas:			☐	☐	☐	☐	
1.			☐	☐	☐	☐	
2.			☐	☐	☐	☐	
3.			☐	☐	☐	☐	
4.			☐	☐	☐	☐	
j)Equipamentos:			☐	☐	☐	☐	
1.			☐	☐	☐	☐	
2.			☐	☐	☐	☐	
3.			☐	☐	☐	☐	
l) **Rebanho**			☐	☐	☐	☐	
1. Vacas			☐	☐	☐	☐	
2. Novilha			☐	☐	☐	☐	
3. Bezerra			☐	☐	☐	☐	
4. Boi			☐	☐	☐	☐	
5. Touro			☐	☐	☐	☐	
6. Bezerro			☐	☐	☐	☐	
7. Novilho			☐	☐	☐	☐	

m)Outros: 1.			☐	☐	☐	☐
2.			☐	☐	☐	☐
3.			☐	☐	☐	☐
4.			☐	☐	☐	☐
5.			☐	☐	☐	☐
6.			☐	☐	☐	☐
TOTAL						

2. PASSIVOS			
2.1 OBRIGAÇÕES			
DISCRIMINAÇÃO	**DESTINO**	**NÚMERO DE PARCELAS**	**VALOR DA PARCELA**
a) COMPRA A PRAZO	1.		
	2.		
	3.		
	4.		

DISCRIMINAÇÃO	**DESTINO**	**NÚMERO DE PARCELAS**	**VALOR DA PARCELA**	**TAXA DE JUROS**
b) EMPRÉSTIMO	1.			
	2.			
	3.			
	4.			
TOTAL				

ATTACHMENT E – Dairy Farm Sales Spreadsheet Used in the Accounting Project

PROJETO AGROECOLOGIA E PAGAMENTO DE SERVIÇOS ECOSSISTÊMICOS – UVM/UFSC/ USP
LABORATÓRIO DE SISTEMAS SILVIPASTORIS - GRUPO DE PASTOREIO VOISIN GPVOISIN UFSC
LABORATÓRIO DE GOVERNANÇA AMBIENTAL (GOVAMB) - UNIVERSIDADE DE SÃO PAULO (USP)

PLANILHA DE VENDAS	
Produtor:	Referente ao mês de:
Comunidade:	Município:
Responsável pelo preenchimento:	Data de entrega da planilha: ______/_______/________
1. LEITE COLETADO (Em litros por data de coleta)	

01	02	03	04	05	06
07	08	09	10	11	12
13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30

31	Total de leite coletados no mês (litros):
	Preço recebido por litro de leite (R$):
	Total (R$):

2. ANIMAIS			
DISCRIMINAÇÃO	**QUANTIDADE**	**VALOR POR QUANTIDADE**	**VALOR TOTAL**
a) Vacas			
b) Novilha			
c) Bezerra			
d) Boi			
e) Touro			
f) Bezerro			
g) Novilho			
		TOTAL	

ATTACHMENT F – Consent of Participation and Use of Information

CONSENTIMENTO DA PARTICIPAÇÃO E USO DE INFORMAÇÃO

Eu,____, portador do CPF:___________________, abaixo assinado, na qualidade de produtor de leite, concordei em participar do Projeto Contábil da Atividade Leiteira de Santa Rosa de Lima –SC, desenvolvido em colaboração pela Universidade Federal de Santa Catarina, Universidade de São Paulo e Universidade de Vermont, nos meses de Abril de 2013 e no período de Agosto de 2013 à Julho de 2014. Fui devidamente informado e esclarecido pela pesquisadora Andrea Castelo Branco Brasileiro Assing sobre a pesquisa e os procedimentos nela envolvidos, assim como a preservação da minha identificação. Afirmo que aceitei participar por minha própria vontade, sem receber qualquer incentivo financeiro e com a finalidade exclusiva de colaborar para o sucesso da pesquisa. Fui informado (a) dos objetivos estritamente acadêmicos do estudo, que, em linhas gerais são elaboração de tese de doutorado, artigos científicos, relatórios, e publicações em eventos.

Fui também esclarecido (a) de que os usos das informações por mim oferecidas estão submetidos às normas éticas destinadas à pesquisa.

Sendo assim, autorizo a aluna de doutorado da Universidade de São Paulo, Andrea Castelo Branco Brasileiro Assing, o uso das informações coletadas para o desenvolvimento da pesquisa e, também, que os resultados do estudo sejam publicados e apresentados em eventos científicos da área.

Santa Catarina, 10 de Outubro de 2015

____

Assinatura do participante