

**“MARKET” PARTICIPATION FOR DEVELOPMENT AND ENVIRONMENTAL
SUSTAINABILITY: COSTA RICAN DAIRY MARKETS AND PAYMENTS FOR
ECOSYSTEM SERVICES**

by

Emily Kathryn Anderson

B.Sc., Mount Allison University, 2004

M.A., The University of British Columbia, 2010

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The following individuals certify that they have read, and recommend to the Faculty of Graduate and Postdoctoral Studies for acceptance, the dissertation entitled:

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Submitted by Emily Anderson in partial fulfillment of the requirements for
the degree of Doctor of Philosophy
in Resource Management and Environmental Studies

Examining Committee:

Kai Chan, Institute for Resources, Environment and Sustainability
Co-Supervisor

Hisham Zerriffi, Department of Forest Resources Management
Co-Supervisor

Sean Smukler, Integrated Studies in Land & Food Systems
Supervisory Committee Member

Nora Angeles, School of Community and Regional Planning
University Examiner

Carol McAusland, Food & Resource Economics
University Examiner

Abstract

Producer participation in markets, including modernized food value chains (MFVCs) and conservation programs like payments for environmental services (PES), is promoted for both human development and environmental sustainability. Participation can benefit farmers but there are concerns that limiting producer choice and concentrating power with intermediaries could have negative consequences for wellbeing and sustainability. PES and MFVCs have similarities for participating producers, suggesting scope for cross-pollination and insight. However, the literatures remain largely separate, tend to consider a narrow set of indicators, and produce mixed results.

This dissertation explores the following questions in the case of dairy farmers in Costa Rica: (1) How and when can producer participation in intermediary-driven food and environmental value chains lead to positive outcomes for wellbeing and sustainability? (2) How and when is it useful to consider PES and food value chains together?

Using statistical and qualitative methods with 217 household surveys and 23 key informant interviews, this dissertation assesses how indicators of human wellbeing, broadly conceived, and agricultural practices differ between farms supplying MFVCs versus traditional dairy value chains, and between those who are and are not participating in PES. Chapter 2 uses an adaptive capacity framing to show that Costa Rican producers selling in MFVCs were likely better equipped to manage change than those selling in traditional markets. Chapter 3 provides evidence that wellbeing in MFVCs also varied between value chains: those selling via a multinational cooperative appear substantially better off than those selling to a private processor.

Chapter 4 presents evidence that PES participants experienced limited material wellbeing benefits from participation; rather, values appeared to be an important motivator for many. Chapter 5 examines correlations between the use of more sustainable agricultural practices and participation in MFVCs and PES. MFVCs appear to be a stronger force than environmental values in shaping farm management choices. This dissertation highlights the value of a broad approach to wellbeing that considers non-material benefits and motivations alongside material ones. Considering Costa Rican PES and dairy market participation together highlights intermediaries and producer-intermediary relationships as important in influencing human and environmental outcomes when farmers participate in MFVCs and PES.

Lay Summary

The participation of farmers in modernized food markets and in payments for environmental services (PES) programs is promoted seeking benefits for both people and nature. For farmers, modernized food markets and PES have similarities: both are controlled by a powerful intermediary firm or organization who decides how these transactions work, with farmers having little opportunity to negotiate. This research explores farmer participation in modernized food markets and PES through a case study of dairy farmers in Costa Rica. The research finds that looking at many material and non-material aspects of human wellbeing helps to understand how these opportunities affect farmers in positive and negative ways. Considering modern markets and PES together highlights how food markets may constrain environmental stewardship and PES, and the importance of intermediaries in shaping outcomes.

Preface

Chapters 2, 3, 4 and 5 of this dissertation were written as stand-alone articles with the intent to publish each in a peer-reviewed academic journal with my committee members as co-authors.

Hence, I use the first-person plural in these chapters, and there is some repetition, particularly in descriptions of research context, study site, and methods.

I led the identification and design of this research, the organization and execution of fieldwork in Costa Rica, data analysis, and the development and writing of all chapters of this dissertation. My supervisors Hisham Zerrieffi and Kai Chan, and to a lesser degree my committee member Sean Smukler, contributed to the development of my ideas and approach at each step of this process, and gave valuable feedback on each chapter once written. My survey instrument and field work approach in Costa Rica benefitted from input from Claudia Sepúlveda at CATIE and Sara Elder, a fellow student at IRES.

This research was conducted with the approval of UBC's Behavioural Research Ethics Boards (Certificate H13-02794).

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List of Abbreviations

AIC	Akaike Information Criterion
BH	Benjamini Hochberg (statistical method to control False Discovery Rate)
CATIE	Centro Agronómico Tropical de Investigación y Enseñanza (<i>Tropical Agriculture Centre for Research and Teaching</i>)
CODEFORSA	La Comisión de Desarrollo Forestal de San Carlos (<i>Commission for Forest Development of San Carlos</i>)
ES	Ecosystem Service
FONAFIFO	Fondo Nacional de Financiamiento Forestal (<i>National Forestry Finance Fund</i>)
ICE	Instituto Costarricense de Electricidad (<i>Costa Rican Electricity Institute</i>)
MAG	Ministerio de Agricultura y Ganadería (<i>Ministry of Agriculture of Costa Rica</i>)
NGO	Non-Governmental Organization
PES	Payments for Ecosystem Services
PSA	Pagos por Servicios Ambientales (<i>Payments for Environmental Services, Costa Rica's national PES program</i>)
SENASA	Servicio Nacional de Salud Animal (<i>Costa Rica's National Animal Health Service</i>)
SES	Social-Ecological System

TEC	Tecnológico de Costa Rica (<i>Technology Institute of Costa Rica, a university in San Carlos</i>)
UBC	University of British Columbia
VIF	Variance Inflation Factor

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Chapter 1: Introduction

1.1 Towards global sustainability

1.1.1 Environment and development

Environmental stewardship and human development are two key interconnected challenges for global sustainability. Humans are altering the planet at speeds and spatial extents not seen elsewhere in nature, dominating and altering Earth's ecosystems via land transformations, alterations of natural cycles, and species introductions and extinctions (Kareiva et al., 2007; Vitousek et al., 1997). Human influence now extends over most of the planet's surface, with our growing population consuming a large and increasing proportion of its resources (Sanderson et al., 2002). Human consumption affects ecosystems, with uneven consumption resulting in uneven impacts across the planet (Imhoff et al., 2004). Across multiple indicators, human consumption is thought to be pushing or exceeding planetary boundaries for sustainability (Steffen et al., 2015).

At the same time, more than 800 million people worldwide live in extreme poverty and struggle to meet their basic needs (UNDP, 2018). Approximately 83% of the world's population live in less developed countries including 13% in Least Developed Countries, proportions that are expected to grow (United Nations, 2014; UN-OHRLLS, 2016). The United Nations Sustainable Development Goals (UNDP, 2018) reflect the need to improve human wellbeing in many parts of the world across multiple dimensions: e.g., economic ("ending poverty", "decent work and economic growth"), meeting basic needs ("zero hunger", "clean water and sanitation", "affordable and clean energy"), equity ("gender equality", "reduced inequalities"), peace

(“peace, justice and strong institutions), social (“sustainable cities and communities”), environmental (“climate action”, “responsible consumption and production”).

The Brundtland report (Brundtland, 1987), released by the United Nations in 1987, was one of the first documents to explicitly link human development and environmental stewardship for a wide and global audience. It is now generally understood that long term human wellbeing is linked to – and dependent on – environmental wellbeing (Bennett et al., 2015; Fischer et al., 2015; MA, 2005; Suich et al., 2015; Summers et al., 2012). The notion of “sustainable development” captures the coupled nature of environmental sustainability and human wellbeing, such that many sustainable development goals and indicators include environmental measures and targets alongside human wellbeing (e.g, Costanza et al., 2016; OECD, 2017; Strezov et al., 2016, UNDP, 2018). It is unlikely we will succeed at securing environmental sustainability without human development, and vice versa.

1.1.2 Agriculture and food systems

Agriculture and global food systems are central to both human development and environmental sustainability challenges. Agricultural sustainability will thus necessarily play a central role in securing environmental sustainability and sustainable development. Agricultural land represents one of the most important global land uses, covering one third of terrestrial ice-free land (Foley et al., 2011; Ramankutty et al., 2008, World Bank, 2015) and making it the largest biome on Earth (Ellis and Ramankutty, 2008). Agriculture and food systems more broadly are also significant consumers of resources and producers of pollution and waste; these systems will need

to reduce their impact considerably for global sustainability (FAO, 2017a; Foley et al., 2011; Ramankutty et al., 2018).

Agriculture and food systems are also key from the perspective of human development.

Agriculture employs nearly 30% of the global population and 68% of those living in low-income countries (World Bank, 2017). Over 70% of those living on less than \$1.25 per day live in rural areas and rely on agriculture for their livelihoods (UNDP, 2017). At the country level, agriculture makes up more than 30% of GDP in low-income countries (World Bank, 2016). To feed a growing global population, it is projected that agricultural production must increase by 50-100% (FAO, 2017a; Foley et al., 2011).

Agriculture embodies the links between environmental sustainability and human development. Farmers rely on agroecosystem sustainability for their long-term wellbeing; producers¹ in developing countries are especially vulnerable to global environmental challenges like climate change (Cohn et al., 2017; Fankhauser and McDermott, 2014; Lipper et al., 2014). Most of the world's farmland is in low and middle-income countries (World Bank, 2017), meaning farmers, and especially small-scale farmers (IFAD, 2016), manage a large proportion of global farmland. It has been suggested that farmers are the largest group of ecosystem managers on the planet (Jackson et al., 2010). Family farms are of particular importance: of the approximately 570 million farms globally (Lowder et al., 2016), about 98% are family farms (Graeub et al., 2016).

¹ Throughout this dissertation, the terms “producer” and “farmer” are used interchangeably to mean a person who grows or raises plants or animals for sale or personal consumption. Given that this work is aimed at an interdisciplinary audience, both terms were included in the writing of dissertation chapters to facilitate searches after publication.

Agricultural sustainability – and thus food systems and farmers – will necessarily be key to advancing both environmental sustainability and human development.

1.2 New opportunities and challenges for farmers: modern food value chains and environmental incentive programs

Recently, two new opportunities are increasingly available to developing country farmers: participation in modern food value chains and in environmental incentive programs. Researchers and practitioners view both as key mechanisms in the realization of environment and/or development goals.

1.2.1 The transformation of food value chains

A value chain documents the “activities that firms and workers perform to bring a product from its conception to end use and beyond” (Gereffi and Fernandez-Stark, 2016). Most food value chains look something like Figure 1.1, with a series of steps from producer to consumer. Different value chains might have more or fewer steps; for example, a producer might sell directly to a consumer, or there might be multiple steps between producer and consumer, including processing, distribution, retail, etc. These “traditional”² food value chains are not vertically integrated, meaning independent actors perform each step in the value chain, with money and products changing hands at each step.

² There is no general agreement in the literature about what to call food value chains pre and post food system transformations. The terms “traditional” and “modern” are used simply to differentiate two broad types of food value chains, with “modern” value chains appearing more recently. The terms are not intended to allude to any additional meaning or connotations that these terms might have elsewhere in the literature or otherwise.

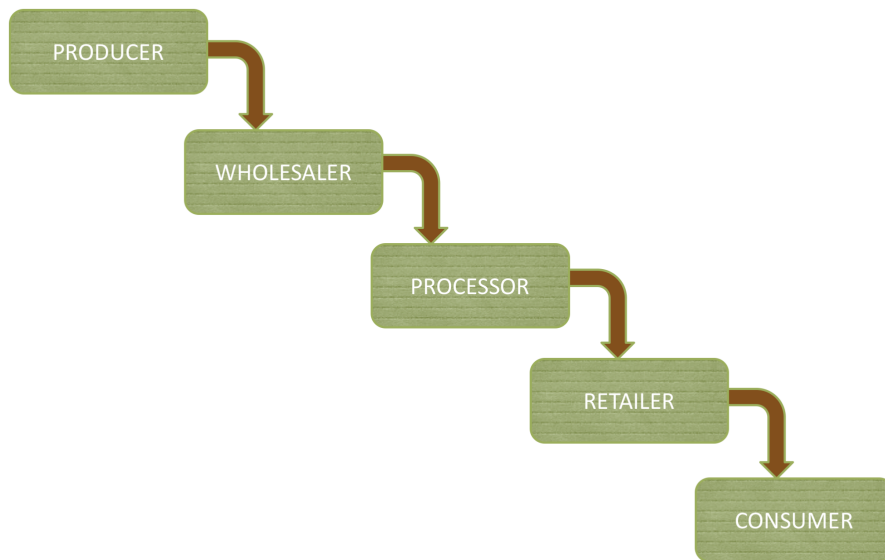


Figure 1.1 Example of a “traditional”, non-vertically integrated food value chain.

Over the last sixty years, there has been a rapid transformation towards an increasingly globalized and coordinated global food system (Busch and Bain, 2004; Reardon et al., 2009). This transformation has involved the entire food system, including the modernization of agriculture and changes in wholesaling, processing and retailing (Reardon et al., 2009). Changes have been driven in part by globalization and trade liberalization, which have resulted in the rapid growth of world trade, internationalization of production by multinational firms, declining information and communication costs, and a significant expansion of food distribution and retail networks (Ericksen, 2008; Pingali, 2007; Reardon et al., 2009). Demand-side factors have also contributed, including urbanization and rising incomes, leading to a rise in demand for non-staple and processed foods like fresh fruits and vegetables and dairy products (Reardon and

Barrett, 2000; Reardon and Berdegúe, 2002; Reardon and Timmer, 2012). A similar account of this transformation describing similar drivers and outcomes is documented across economic, geography and sociology literatures (Busch and Bain, 2004).

These changes in food systems have resulted in a growing number of “modernized” food value chains characterized by consolidation, vertical coordination, rapid organizational change, private governance via product standards, and by powerful, large-scale intermediary firms – usually processors or retailers – participating in and controlling multiple steps along the value chain between producers and consumers (Barrett et al., 2012; Busch and Bain, 2004; Gereffi et al., 2005; IFAD, 2016; Isakson, 2014; Okello and Swinton, 2007; Otsuka et al., 2016; Reardon et al., 2009; Reardon and Barrett, 2000; Reardon and Timmer, 2012; Wang et al., 2014). Vertical coordination is accomplished via mechanisms that include contracting and bringing other value chain functions “in house” into coordinating firms or their subsidiaries. Figure 1.2 shows an example of a modernized food value chain.

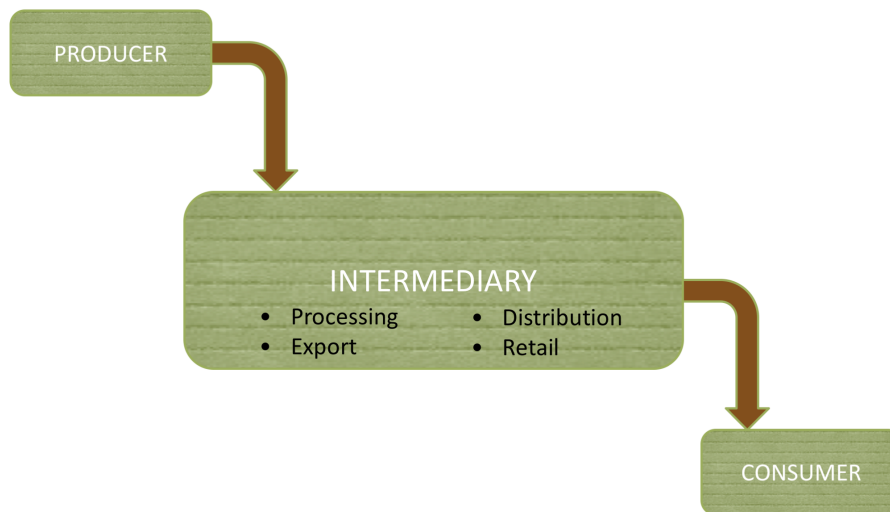


Figure 1.2 Example of a “modernized”, vertically coordinated food value chain.

Although there is broad agreement on the drivers and general characteristics of this food system transformation, there is no universal definition of a modernized value chain (or universal name for these value chains). While many modern value chains involve export markets with multinational firms acting as controlling intermediaries in the value chain, this is not universal. A subset of the modern value chain literature describes a “supermarket revolution” involving large retailers who may be either national or multinational in scope (Humphrey, 2007; Reardon and Berdegúe, 2002). Contracting is a widely used mechanism of vertical coordination in modernized value chains (Okello and Swinton, 2007); the literature focused specifically on contract farming arrangements usually pertains to modernized value chains (e.g., Barrett et al., 2012; Otsuka et al., 2016).

This dissertation differentiates modernized value chains as being highly vertically coordinated, usually by a single powerful and controlling intermediary firm. In the case of dairy value chains operating in Costa Rica, the focus of this dissertation, the controlling firm is usually a food processing company. Modernized value chains also tend to have spatially distant producers and consumers and include strict quality standards. By contrast, traditional value chains are not vertically coordinated, and value chain actors at each step often have greater autonomy. Producers and consumers are more likely to be spatially proximate, with consumers often living in the same region as producers. Product quality tends to be more variable and less formally regulated. While thinking about value chains in two distinct categories can be useful for advancing research and understanding, in practice, food value chains do not always fall tidily into two mutually exclusive categories; rather, value chains tend to fall across a spectrum representing more or less modern value chain characteristics. In the overview of the dissertation case study below, I highlight one particular value chain in Costa Rica that has characteristics of both, how it was treated in my analyses, and why.

1.2.2 Environmental incentive programs

Environmental incentive programs represent another growing opportunity for developing country producers. There is hope that these programs might deliver benefits for both environmental sustainability and human development (Anderson and Zerriffi, 2012). In typical market transactions, environmental effects are often externalized, meaning they are not accounted for in the transaction. These environmental externalities are typically addressed via initiatives of governments and non-governmental organizations (NGOs). Around the turn of the 21st century,

shifts in funding for environmental programs from public to private funding have resulted in a rise in popularity of more “business-type” approaches to conservation (Wunder, 2006), and in the development of several types of market-inspired instruments to incentivize pro-environmental action (Swallow et al., 2009). At the same time, multinational firms have increasing power and influence in environmental governance (Dauvergne and Lister, 2011; Fuchs et al., 2011), meaning that the private sector is playing an increasingly important role in environmental sustainability.

One widely-implemented category of market-based environmental incentive programs is payments for ecosystem services (PES). Environmental or ecosystem services (ES), the processes by which nature provides benefits for people (Levine and Chan, 2011), provide the framing for PES. PES include a spectrum of mechanisms where ES users, and others who wish to support ES provision, pay for positive incentives to secure desired actions from ES providers, and consequent flows of ES (Sommerville et al., 2009; Swallow et al., 2009; Wunder et al., 2008). PES transactions – or “PES value chains” if PES is thought of like a market transaction – involve an ES buyer who pays to secure streams of ES, an ES provider who agrees to certain actions to secure ES flows, and almost universally, an intermediary who connects buyers and providers and who designs, implements and administers the PES transaction. PES intermediaries may be public agencies including governments and NGOs, or less commonly, firms. In some cases, the intermediary oversees transactions directly between ES buyers and providers; in other cases, the intermediary (often a government body in this case) pays for the PES program and ES provision on behalf of the public using public funds (e.g., from taxes). In the latter case, the PES transaction does not directly involve ES beneficiaries (the public). Typically, PES transactions

are facilitated by a regional individual or organization with knowledge of both the PES program and ES providers.

Framings of PES vary considerably across the literature. Initially, economic valuation and quantification approaches dominated (Corbera et al., 2009), generally applying a Coasean³ conceptualization and taking a more strict market approach to PES and their definition (e.g., Engel et al., 2008; Wunder, 2005). Wunder (2005) provided one of the earliest and most widely referenced definitions, defining PES as a conditional voluntary transaction between at least one ES buyer and one ES provider and involving well-defined and measurable ES. Wunder (2015) went on to later emphasize conditionality as a key feature of this definition. Economic conceptualizations in general tend to strongly emphasize notions of conditionality (incentives are only awarded when ES are provided, as determined by measurement and monitoring) and additionality (the incentive program results in ES provision over and above what would have been provided in the absence of the program).

In practice, most programs do not meet all of Wunder's criteria (Sommerville et al., 2009; Swallow et al., 2009; Vatn, 2010), and most are not true market transactions (Vatn, 2015). Alternative conceptualizations and frameworks have emerged, ranging from frameworks expanding on economic conceptualizations (e.g., Sommerville et al., 2009), to more substantial shifts like that proposed by Muradian et al. (2010), who frame PES as part of a broader, multi-

³ Coase Theorem describes economic efficiency in the presence of externalities, stating that trade in externalities in the absence of transaction costs will lead to an efficient outcome. In the case of PES, ES are conceptualized as externalities to most economic transactions. Where PES allows trade in these externalities, a Coasian approach would suggest that PES will contribute to increasing economic efficiency overall.

goal approach to rural development, and other institutional approaches (Corbera et al., 2009; Swallow et al., 2010) that emphasize PES design, context specificity and institutional context and structure in shaping PES implementation and outcomes. In this dissertation, I use a broad definition of PES that includes a spectrum of environmental incentive programs designed to provide positive incentives in exchange for ES provision, including PES that do not fit the narrow definition of a true market transaction⁴. Included programs may be part of broader multi-policy approaches to securing environmental outcomes and may include both monetary and non-monetary incentives.

1.2.3 Human development and environmental wellbeing

Inclusion of developing country farmers in modernized food value chains is increasingly presented as both desirable and necessary for rural development by researchers, organizations, and governments (e.g., Barrett et al., 2012; Helmsing and Vellema, 2011; IFPRI, 2016; Slingerland et al., 2006; Taglioni and Winkler, 2014; Weatherspoon and Reardon, 2003).⁵ At the same time, many PES programs have been implemented in developing countries, based on hope that PES, when well-designed, can deliver both environmental and human development benefits

⁴ For example, many PES programs are administered by governments who use public revenues (e.g., tax income) to fund the programs to benefit the public. Because the public does not directly choose to participate in the transaction, it is not technically voluntary, and therefore, not a pure market transaction.

⁵ Notably, it is not universally advocated that farmers should be connected to coordinated value chain opportunities. For example, Fuchs and Kalfagianni (2017) express common concerns in the Political Economy literature that the governance of modern food systems by powerful companies in coordinated value chains contributes little to improving human and environmental wellbeing, and where benefits exist, they tend to accrue to a minority. Acknowledging these concerns and the importance of questions of whether farmers *should* be connected to coordinated value chains, this dissertation starts from a position that farmers are *already* being connected to coordinated value chains, and as such, it will be important to understand how to involve farmers in these opportunities to secure the best outcomes possible.

(Bulte et al., 2008; Corbera et al., 2009; Engel et al., 2008; Muradian et al., 2010; Wunder, 2007).

However, the human and environmental wellbeing outcomes of participation are not clear-cut. For example, in terms of human wellbeing, many studies focus on increased income as both a primary motivator for farmer participation in these opportunities and a key measure of human wellbeing as a result. A broader reading of the literature suggests that modernized food value chains and PES present a mixture of opportunities and challenges to farmers.

Modernized food value chains can help producers to access distant markets, training, inputs and technology, and can increase income and stability (Barrett et al., 2012; Minten et al., 2009; Otsuka et al., 2016; Ruben and Sáenz, 2008; Van der Meer, 2006). Potential challenges for farmers in these value chains include decreased livelihood flexibility and ability to negotiate (González and Nigh, 2005; Isakson, 2014; Klasen et al., 2016; Reardon and Barrett, 2000; Shaver et al., 2015). In addition, strict quality and quantity requirements and delayed payments can restrict access to these markets, particularly for smaller and less well-off farmers (Barrett et al., 2012; Lee et al., 2012; Schwentesius and Gómez, 2008; Soper, 2015).

Like modernized food value chains, PES programs can provide both opportunities and challenges to farmers. Benefits of PES participation can include the potential for additional income generation (Cole, 2010; Grieg-Gran et al., 2005; Jindal et al., 2008; Kosoy et al., 2008; Pagiola et al., 2005; Tacconi et al., 2010; Wunder and Albán, 2008) and access to non-monetary resources like technical training (Tacconi et al., 2010). Evidence has also been found that PES

can improve landowner relationships with public sector and non-governmental organizations, and increase land tenure security (Grieg-Gran et al., 2005; Locatelli et al., 2008; Miranda et al., 2004). Challenges can include reduced livelihood and land use flexibility for PES participants due to contract arrangements (German et al., 2010). Like modernized food value chains, several studies describe power inequalities in PES, with small farmers generally having less power than those setting the terms of and administering the transaction (Corbera et al., 2007a; Kosoy and Corbera, 2010). High transaction costs and administrative requirements in PES can reduce benefits and exclude some potential participants (Cacho et al., 2005; Corbera et al., 2007a; Swallow and Meinzen-Dick, 2009; Wunder, 2007). It has been suggested that bundling services could increase payments for an area, thereby lowering costs (Kemkes et al., 2010), but as yet this approach is not widely implemented. There is evidence that those who are better off and more educated have greater access to PES programs and benefit more from PES programs (Börner et al., 2010; Grieg-Gran et al., 2005; Pagiola et al., 2005; Porras et al., 2013; Tacconi et al., 2010).

The literature also suggests a range of outcomes pertinent to environmental and agricultural sustainability. Research relevant to environmental outcomes in modern food value chains has focused largely on the consequences of agricultural intensification common in these value chains. Generally, less attention has been given to environmental outcomes compared to human wellbeing outcomes. Studies have found evidence of reduced biodiversity and ES provision with the intensification and specialization commonly required to supply modernized value chains (Lambin et al., 2001; Power, 2010; Zimmerer, 2010). Evidence has also been found of increased input use to meet quantity and quality requirements (Barrett et al., 2001); however, input use can also decrease in modernized markets due to access to information and food safety standards, for

example that restrict pesticide residues on food (Berdegué et al., 2005; Cavatassi et al., 2011; Galt, 2008). In the case of PES, most studies of environmental outcomes focus on the specific ES targeted by the PES program, with documented positive outcomes including increases in forest cover and carbon sequestration (Wunder and Albán, 2008). Given the potential for unintended negative effects for non-target ES (Bremer and Farley, 2010; Farley et al., 2005; Wunder, 2005), studies of program effects on non-target ES would be prudent but are uncommon.

In short, both modernized food value chains and PES have been associated with positive and negative outcomes for farmers and the environment. This raises the question as to when and how these opportunities can deliver more positive outcomes across a broad spectrum of human and environmental wellbeing indicators, and meaningfully contribute to sustainable development.

1.2.4 Coordinated “market” opportunities

From the perspective of producers in particular, modern food value chains and PES are two opportunities with some striking similarities. First, modern food and PES value chains have a common “coordinated value chain” structure (Figure 1.3). In both cases, an intermediary actor links farmers to end buyers or beneficiaries. In both cases, value chain actors are often spatially distant. This intermediary actor coordinates their value chain through mechanisms like contracting, exerting considerable control over other actors and activities in the value chain.

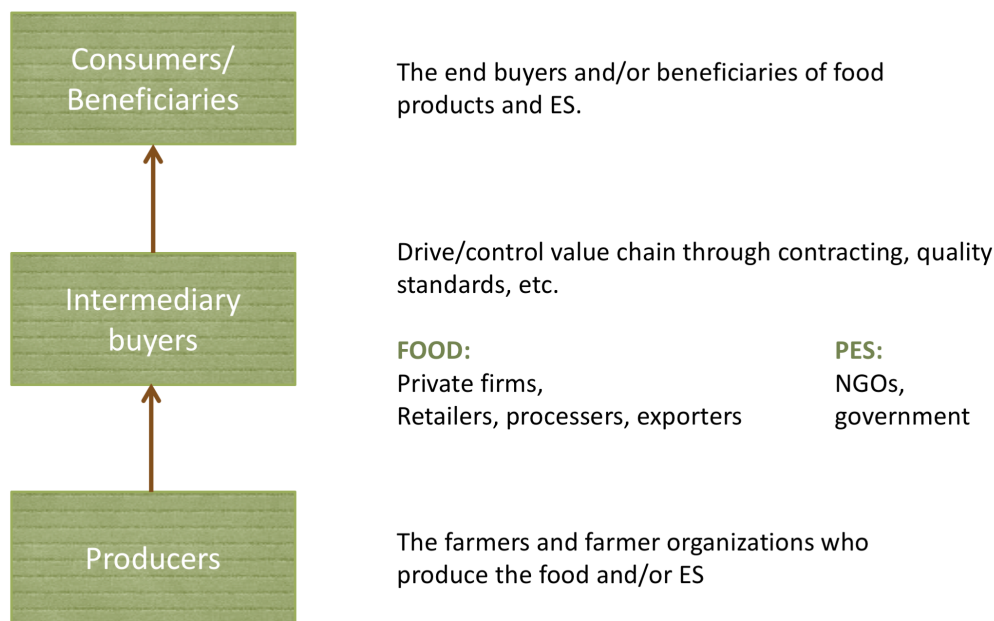


Figure 1.3 The “coordinated value chain” structures of modernized food value chains and PES transactions. Both modernized food value chain and PES literatures emphasize the dominance of intermediaries in these transactions.

While it is hoped that both PES programs and modern value chains can benefit participating producers, the literature documents similar challenges facing farmers engaged in both modernized food markets and PES programs, partly as a result of their coordinated structure. In both cases, the intermediary actor has significant control over how the transaction unfolds. In modern food value chains, an intermediary firm exerts significant influence over the terms of farmer participation via mechanisms that include contracts and food quality standards (Fuchs et al., 2011; Lee et al., 2012; Reardon and Barrett, 2000; Reardon et al., 2009). Producer participation in negotiation and decision-making is often limited (González and Nigh, 2005;

Reardon and Barrett, 2000). Similarly, in PES programs, the intermediary typically dominates the transaction and defines the terms of participation, including the characteristics of the ES “product”, the rights of transaction actors, and the size and timing of payments (Muradian et al., 2010; Vatn, 2010). In both cases, farmers can choose whether or not to participate, but typically have little ability to negotiate the terms of their engagement, including how and when products are provided and when payments are made. There is concern that both modern food value chains and PES programs can limit livelihood flexibility for participants via contract arrangements (German et al., 2010; Key and Runsten, 1999).

Similar barriers can also exclude farmers – particularly smaller-scale farmers – from both modern food value chains and PES programs. In both cases, while not universal, these opportunities can favour larger-scale producers who can offer greater economies of scale (Anderson and Zerriffi, 2012; Grieg-Gran et al., 2005; Reardon et al., 2009). There is also evidence that farmers who are better-off often have greater access to modern food value chains (Briones, 2015; Otsuka et al., 2016; Reardon et al., 2009) and PES programs (Anderson and Zerriffi, 2012; Börner et al., 2010; Grieg-Gran et al., 2005; Pagiola et al., 2005).

Despite these similarities, the literature and initiatives centred around farmer participation in modernized food markets and environmental incentive programs are largely separate, precluding proper comparisons and examination of interactions and joint effects. Potentially important differences between these two opportunities must be acknowledged including: tangible versus intangible products, true market versus market-like transactions, firm versus government or NGO intermediary actors, primary versus supplementary livelihood activities. Nevertheless,

similarities in the barriers and challenges that producers face in accessing these opportunities and in the structure of the “value chains” raise the question as to whether it might be useful to think about these two opportunities together. Given that some farmers have both PES and modernized value chain opportunities available at the same time, and given that similar challenges associated with PES and modernized food value chains have been approached by different groups of researchers with different backgrounds and knowledge bases, it is possible that considering these opportunities together could provide the potential for novel insights and synergy in initiatives to further environmental sustainability and human development.

1.3 Research objectives

This dissertation contributes knowledge to gaps in the literature identified above related to narrow explorations of human wellbeing and environmental outcomes. It also addresses the separation of academic and applied communities involved with farmer participation in modernized food markets and PES and aims to speak to the potential for learning and insight if these opportunities are considered together. Accordingly, the research presented in this dissertation is driven by the following underlying research objectives:

1. When wellbeing is broadly conceived, to better understand how and when can coordinated value chain opportunities (including both modernized food value chains and PES) contribute effectively to human and environmental wellbeing.
2. To understand whether and how modernized food value chains and PES might be comparable, and what their relative contributions and joint effects are on human and environmental wellbeing.

Each dissertation body chapter primarily contributes to objective 1, exploring a broad spectrum of wellbeing indicators and farming practices (as proxies of environmental impacts) in dairy value chains and the federal PES program in Costa Rica. Objective 2 is explored in part in Chapter 5, and then revisited in the dissertation conclusion. A more detailed overview of the dissertation structure is provided below, including identification of specific literature gaps addressed by each chapter.

The rest of this introductory chapter will first outline the research framework of this dissertation, including how food and agricultural systems and wellbeing are conceptualized in this study. It will then provide an overview of the dissertation research, including the Costa Rican case study and methods that forms the basis of this research. The introduction concludes with an outline of the dissertation chapters.

1.4 Research framework

1.4.1 Agriculture and food systems

This dissertation draws on social-ecological systems (SES) thinking to conceptualize agricultural and food systems. SES are “complex adaptive systems characterized by feedbacks across multiple interlinked scales” (Fischer et al., 2015, p.145). SES are characterized by uncertainty, complexity, transformation and change, reciprocal reactions and feedbacks, and non-linearity and thresholds (Fischer et al., 2015; Holling, 2001; Liu et al., 2007). The SES concept was chosen because it is flexible and useful for framing human-environment interactions (Fischer et al., 2015; Fisher et al., 2014), and has been applied to agricultural systems (Darnhofer et al., 2010; Kremen et al., 2012).

The research presented in this dissertation focuses on individual value chains and on producers (and their farms) within these value chains. Food value chains and their actors are embedded in a wider food system SES and are understood to be useful entry points in influencing food system sustainability (Tendall et al., 2015). An SES approach highlights the multifaceted human-environment interactions and relationships that characterize food systems, and the evolution of agricultural and food systems over time (Chapman et al., 2017; Kremen et al., 2012).

While focusing primarily on the farm level, this research also includes consideration of broader scales influencing the farm level. Scale is a key consideration in SESs, including agricultural SES, which are characterized by interactions within and across embedded levels (Chapman et al., 2017; Holling, 2001). Consideration of scale is important in the context of food value chain globalization and global-scale influences on agricultural systems, like climate change. This research focuses primarily on farm-level actions and effects, the scale at which farmers generally have the greatest and most immediate influence, and at which farming households tend to feel most strongly the effects of global phenomena (e.g., the effects of global climate change on local weather patterns and agricultural yields). Other scales of influence are brought into consideration in the analyses via document review and interviews with key informants at broader scales. Because sustainable development implies the wellbeing of people and their environment for future generations, this research also incorporates the consideration of temporal scale via the inclusion of future wellbeing indicators (see discussion of adaptive capacity below).

1.4.2 Wellbeing and sustainable agriculture

Wellbeing has been addressed across a diversity of disciplines and approaches. While there is no universal consensus about what factors should be included in understanding wellbeing and how to measure these factors (Gasper, 2004), few would argue that wellbeing goes beyond commonly-used income and economic measures. It is widely understood that wellbeing is a multidimensional concept that includes both objective (e.g. material goods, social relationships) and subjective (e.g. feelings about quality of life) components (Breslow et al., 2016; Hicks et al., 2016; King et al., 2013). These components can be measured in a variety of ways including self-report and non-self-report methods (Gasper, 2004). Many conceptualizations of wellbeing now also include understanding that human wellbeing is linked to ecological factors (Breslow et al., 2016; Chambers and Conway, 1992; King et al., 2013; Summers et al., 2012).

To develop a broad understanding of what contributes to wellbeing and how to measure it, I consulted both academic and grey literature from various areas of research and implementation, including development studies and sustainable development, psychology and subjective wellbeing, environmental studies, environmental conservation, ecosystem services, SES and coupled human-environmental systems, sustainability studies, resilience, adaptive capacity and adaptation, and vulnerability. A set of variables and indicators expected to be particularly relevant in this study were chosen based on the modern value chain and PES literatures, and on understanding of the case study context.

Present wellbeing components and indicators included in this study focus on the tangible and intangible assets that (farm) systems have now (Table 1.1). Though drawn from a broader

literature, present wellbeing components are framed using Livelihood Capitals categories (Scoones, 1998) because this framework is widely used and understood by both researchers and practitioners. It is hoped that this might make this research more accessible and applicable in non-academic settings. Because the Livelihood Capitals focus on objective wellbeing factors, an additional Subjective Wellbeing category is included. In this research, I use a standardized Satisfaction with Life scale (Diener et al., 1985) to explore subjective wellbeing because it is a widely used and highly validated measurement tool (Kobau et al., 2010).

Sustainability and sustainable development also imply human and environmental wellbeing that continues into the future and in the face of change (Anand and Sen, 2000; Breslow et al., 2016; Chambers and Conway, 1992; OECD, 2017). I thus used adaptive capacity, adaptation and vulnerability literatures to build a set of factors thought to contribute to a (farm) system's ability to positively cope with and respond to the change inherent in SES, and in food systems in the face of globalization and climate change (Table 1.2). I used an adaptive capacity framework adapted from (Bennett et al., 2014; Cohen et al., 2016) to frame components contributing to future wellbeing; a more detailed overview of the adaptive capacity concept and my framework is included in Chapter 2.

I consider environmental wellbeing by exploring agricultural practices as a proxy. Agricultural practices and understanding of their expected environmental effects were drawn from the sustainable agriculture literature (e.g., Foley et al., 2011). I drew on several sustainable agriculture concepts, including organic agriculture (e.g., CGSB, 2015; Sandhu et al., 2010; Seufert and Ramankutty, 2017), green agriculture (Koohafkan et al., 2012), diversified farming

systems (Kremen et al., 2012), and agroecosystem resilience and adaptation (e.g. Cabell and Oelofse, 2012; Howden et al., 2007). Common ideas about sustainable practices can be found across concepts (Koochafkan et al., 2012), and generally involve practices that conserve resources and improve natural capital (Pretty, 2008). Farmers influence environmental wellbeing at multiple scales via their choices of agricultural inputs and technologies, land uses, and water and soil management practices. For example, animal fertilizer application, particularly raw manure, can contribute to eutrophication of local waterways (Carpenter et al., 1998; Puckett, 1995); different dairy waste management practices contribute in varying degrees to global greenhouse gas emissions depending on the method (Owen and Silver, 2014). More details about the environmental effects of agricultural practices considered in this research are given in the Methods section of Chapter 5.

Table 1.1 Present wellbeing variables and indicators, organized in terms of Livelihood Capitals (Scoones, 2009; 1998): Economic (E), Social (S), Human (H) and Natural (N) capital categories, plus and additional Subjective Wellbeing (SW) category.

Wellbeing Variable	Expected variable relationship with:	Indicator(s)
	<ul style="list-style-type: none"> ➔ Participation in modern food value chains (MVC) ➔ Participation in payments for environmental services (PES) 	<ul style="list-style-type: none"> ⬆ Expected relationship with wellbeing
Wealth (E) 28,45,47	<ul style="list-style-type: none"> ➔ Wealth can facilitate MVC participation (Briones 2015; Reardon et al. 2009); Higher prices in MVC can increase wealth^{3,4,31,39,42} ➔ Wealth can facilitate PES participation and ability to benefit from PES^{e.g.,5,10}; Participation in PES can increase income and wealth^{17,18}. PES participation has been correlated to farm size, an indicator of wealth³⁴ 	<ul style="list-style-type: none"> ⬆ Wealth index ⬆ Milk price ⬆ Farm size
Production efficiency (E)	<ul style="list-style-type: none"> ➔ MVCs could facilitate more efficient production where they provide access to inputs and information ➔ Where higher efficiency correlates to better margins and greater wealth, this can facilitate access to PES programs 	<ul style="list-style-type: none"> ⬆ % of total cows that are milked ⬆ Number of cows per worker
Information (H) 45	<ul style="list-style-type: none"> ➔ Use of information for farm management and ability to navigate information sources could facilitate meeting MVC standards²¹; Some MVC intermediaries facilitate access to information for suppliers^{3,31} ➔ Some PES programs offer participants access to information and resources 	<ul style="list-style-type: none"> ⬆ Number of information sources ⬆ Use of and number of information sources (producer cooperative, government, commercial, family, community, NGO) informing farm management
Education (H) 20,28,45,47	<ul style="list-style-type: none"> ➔ Education and training can facilitate access to MVC^{31,38,39}; Some MVC intermediaries offer suppliers access to training^{3,31}. ➔ Education and training can help farmers access PES^{32,34} 	<ul style="list-style-type: none"> ⬆ Education of household head ⬆ Highest education achieved by a household member

Wellbeing Variable	Expected variable relationship with:	Indicator(s)
	<p>→ Participation in modern food value chains (MVC)</p> <p>→ Participation in payments for environmental services (PES)</p>	<p>↑ Expected relationship with wellbeing</p>
Social connection - Organization participation (S) 20,26,28,30	<p>→ Cooperatives facilitate access to some MVCs³; Some buyers contract only with producer groups³¹</p> <p>→ PES participation can improve connections to and support from organizations²⁵</p>	<p>↑ Household participates in organization(s)</p> <p>↑ Number of types of organization household involved with</p>
Social connection - Access to communication tools (S) 20,26,28	<p>→ Communication technology assists organization and access to information, which facilitates MVC access^{6,21,39,43}</p> <p>→ Communication technology assists organization and access to information, which could facilitate PES access</p>	<p>↑ Access to computers, internet, and/or email</p>
Trust (S) 20	<p>→ Trust and good relationships between producers and buyers have been associated with producer wellbeing and relationship longevity in MVCs^{15,49}</p> <p>→ Trust and relationships with PES intermediaries and within communities are thought to be important in mediating program outcomes^{9,48}</p>	<p>↑ Trust milk buyer</p> <p>↑ Trust PES intermediary</p> <p>↑/↓ Relationship with milk/PSA buyer reported as a benefit/challenge</p>
Self-reported Wellbeing (SW) 13,28,33,45	<p>→ Stability and better prices in MVC might make farmer feel like they are better off</p> <p>→ PES could bring people satisfaction by helping them to fulfill their own values and perceived social expectations²⁹</p>	<p>↑ Standardized questions – individual</p> <p>↑ Combined score</p>
Farm success (SW) 11,12,22	<p>→ Ability to participate in MVC might make farmer feel more successful</p>	<p>↑ Perceived farm success</p>

Wellbeing Variable	Expected variable relationship with:	Indicator(s)
	<p>→ Participation in modern food value chains (MVC)</p> <p>→ Participation in payments for environmental services (PES)</p>	<p>↑ Expected relationship with wellbeing</p>
Input use (N/H) 8,14,24,36,37,45,46	<p>→ MVC participation can increase input use^{2,40} – raising concerns about both negative environmental and human health impacts; MVCs could support supplier uptake of novel practices including more sustainable farming practices^{6,19,27,40}</p> <p>→ PES could incentivize more sustainable farming practices, including changes in input use</p>	<p>↓ Use inputs: fertilizers, pesticides, herbicides, prophylactic antibiotics, hormones</p>
Water management strategies (N) 8,23,35,41	<p>→ MVCs could support supplier uptake of novel practices including more sustainable farming practices^{6,19,27,50}; irrigation may facilitate MVC participation but water is often used inefficiently³⁵</p> <p>→ PES programs can incentivize water course protection and other water management practices³⁵</p>	<p>↑ Use irrigation</p> <p>↑ Have watercourse protection (e.g. vegetation buffer)</p> <p>↑ Use of troughs</p>
Land use (N) 1,23,35	<p>→ Production, quality and quantity requirements in some MVCs could change or constrain land management⁴⁴; Specialization common to supply MVCs can result in more monocropping and reduced land use complexity²³</p> <p>→ PES programs can incentivize land use changes, including habitat conservation, tree planting, etc.</p>	<p>↑ Land left fallow</p> <p>↑ Land set aside for conservation</p> <p>↑ Use of agroforestry practices (trees planted in pastures, fences, forage banks)</p> <p>↑ Pasture rotation</p>
Waste management (N) 8,35,36	<p>→ MVCs could support supplier uptake of novel practices including more sustainable farming practices^{16,19,27,50}</p> <p>→ PES programs could incentivize more sustainable farming practices, including waste management practices³⁵</p>	<p>↑ Compost milking area waste</p> <p>↑ Use biodigester for milking area waste</p>

1. (Albrecht and Kandji, 2003) 2. (Barrett et al., 2001) 3. (Barrett et al., 2012) 4. (Bellemare, 2012) 5. (Börner et al., 2010) 6. (Boselie et al., 2003) 7. (Briones, 2015) 8. (Carpenter et al., 1998) 9. (Corbera et al., 2007a) 10. (Corbera et al., 2007b) 11. (Deci and Ryan, 2000) 12. (Diener et al., 2010) 13. (Diener et al., 1985) 14. (Gavrilescu et al., 2015) 15. (Gereffi and Luo, 2014) 16. (Gomez et al., 2011) 17. (Greiner and Stanley, 2013) 18. (Grieg-Gran et al., 2005) 19. (Hartmann, 2011) 20. (Helliwell and Putnam, 2004) 21. (IFPRI, 2016) 22. (Kobau et al., 2010) 23. (Kremen et al., 2012) 24. (Li, 2014) 25. (Locatelli et al., 2008) 26. (Milner-Gulland et al.,

2014) 27. (Mylan et al., 2015) 28. (OECD, 2017) 29. (Ortiz Malavasi et al., 2003) 30. (Ostrom, 2009) 31. (Otsuka et al., 2016) 32. (Pagiola et al., 2005) 33. (Pavot and Diener, 2008) 34. (Porrás et al., 2013) 35. (Pretty, 2008) 36. (Puckett, 1995) 37. (Ramankutty et al., 2018) 38. (Reardon et al., 2001) 39. (Reardon et al., 2009) 40. (Ruben and Sáenz, 2008) 41. (Schoumans et al., 2014) 42. (Schuster and Maertens, 2013) 43. (Schwentenius and Gómez, 2008) 44. (Stuart, 2008) 45. (Summers et al., 2012) 46. (Tschardt et al., 2012) 47. (UNDP 2018) 48. (Vatn, 2010) 49. (Vorley et al., 2012) 50. (Zanillo et al., 2015)

Table 1.2 Adaptive capacity (future wellbeing) variables and indicators, organized according to categories adapted from Bennett et al. (2014) and Cohen et al. (2016): Access to Assets (A), Flexibility and Diversity (F), Learning and Knowledge (L), Capacity to Organize (O), Agency (Ag).

Adaptive Capacity Variable	Expected variable relationship with:	Indicator(s)
	<ul style="list-style-type: none"> → Participation in modern food value chains (MVC) → Participation in payments for environmental services (PES) 	<ul style="list-style-type: none"> ↑ Expected relationship with adaptive capacity
Wealth and non-monetary assets (A) 5,12,15,16	<ul style="list-style-type: none"> → Wealth can facilitate MVC participation^{11,50}; Higher prices in MVC can increase wealth^{3,4,44,50} → Wealth can facilitate PES participation and ability to benefit from PES^{e.g.,7,17}; Participation in PES can increase income and wealth^{29,30} 	<ul style="list-style-type: none"> ↑ Wealth Index
Technology use (A) 32,33,41	<ul style="list-style-type: none"> → Inputs can facilitate meeting quantity and quality requirements in MVC; Some MVC intermediaries provide access to inputs for their suppliers³ → Communication technology assists organization and access to information, which facilitates MVC access^{7,3450,53} → Communication technology assists organization and access to information, which facilitates PES access 	<ul style="list-style-type: none"> ↑ Use of inputs: herbicides, pesticides, fertilizers, antibiotics, hormones ↑ Use of computer, internet, email
Credit and subsidies (A) 5,9,12,14,15,33	<ul style="list-style-type: none"> → Facilitates investment to meet CM standards⁵³; Some MVC intermediaries provide credit to suppliers^{3,44} → Facilitates paying up-front costs of participation in PES (e.g., administrative costs, seedlings for reforestation, etc.) 	<ul style="list-style-type: none"> ↑ Access to credit

Adaptive Capacity Variable	Expected variable relationship with:	Indicator(s)
Access to non-monetary support services (A) 9,20,46	<p>→ Participation in modern food value chains (MVC)</p> <p>→ Participation in payments for environmental services (PES)</p> <p>→ Can facilitate market access^{2,53}; Some MVC intermediaries provide access to services like technical and veterinary support^{3,44}</p> <p>→ PES program may provide non-monetary incentives like technical support</p>	<p>↑ Expected relationship with adaptive capacity</p> <p>↑ Receive non-monetary support (e.g. agricultural extension services)</p>
Agroecosystem sustainability (A) 10,13,25	<p>→ MVCs can favour practices that decrease agricultural sustainability and the provision of ecosystem services by agricultural systems^{39,47}; MVCs could support supplier uptake of novel practices including more sustainable farming practices^{27,31,42,59}</p> <p>→ PES is designed to increase ES provision by the farm</p>	<p>↑ Sustainable agricultural practices: Active watercourse protection Waste management (compost, biodigestion); Land set aside for conservation; Land left fallow; Agroforestry practices; Less input use</p> <p>↑ Environmental motivations important in farm management</p>
Livelihood and income diversity and flexibility (F) 5,12,13,14,15,23,33,55,	<p>→ Access to stable non-farm income could facilitate investment required to enter MVC; Specialization to sell to MVC can reduce household income streams³⁷; Contracts, which can restrict livelihood options³⁶, are a common method of vertical coordination in MVC⁴³</p> <p>→ PES can provide additional stream of household income or resources²⁹</p>	<p>↑ Number of household income streams</p> <p>↑ Household has off-farm income</p> <p>↑ Diversity of sources of credit, non-monetary support</p> <p>↑ Number of farm products</p> <p>↓ Farm has dairy or PES contract (or cooperative agreement)</p> <p>↑/↓ Flexibility cited as benefit/challenge of current dairy market or PES</p> <p>↑ PES listed as one of households 3 most important income streams</p>

Adaptive Capacity Variable	Expected variable relationship with:	Indicator(s)
	<ul style="list-style-type: none"> → Participation in modern food value chains (MVC) → Participation in payments for environmental services (PES) 	<ul style="list-style-type: none"> ↑ Expected relationship with adaptive capacity
On-farm flexibility and diversity (F) 6,13,14,18,35,39,43,48	<ul style="list-style-type: none"> → Requirements to sell in MVC that favour qualities like specialization and intensification can lead to reductions in farm diversity and ecosystem services^{37,39,46,51,54} → PES program can incentivize actions that increase farm diversity, including increasing land use diversity or species diversity in farmed landscapes; PES can restrict uses of land 	<ul style="list-style-type: none"> ↑ Number of cattle varieties, farm products, land uses ↑ Variation of land use, farm products, cattle varieties year-to-year ↓ Land use freedom cited as challenge in PES
Experience (L) 18,24,32,46,56	<ul style="list-style-type: none"> → Experience might facilitate ability to participate in MVC⁴ → Experience thought to facilitate PES participation⁴⁵ 	<ul style="list-style-type: none"> ↑ Years as farmer, cattle farmer ↑ Years farming current land ↑ Years in current dairy market
Education (L) 2,5,12,14,16,32,46	<ul style="list-style-type: none"> → Education and training can facilitate access to MVC^{44,49,50}. Some MVC intermediaries offer suppliers access to training^{3,44} → Education thought to facilitate PES participation⁴⁵ 	<ul style="list-style-type: none"> ↑ Education of household head ↑ Highest education of a household member ↑ Access to training seen as a benefit of current dairy market, PES
Access to information (L) 1,2,5,16,32,34	<ul style="list-style-type: none"> → Use of information for farm management and ability to navigate information sources could facilitate meeting MVC standards³⁴; Some MVC intermediaries facilitate access to information for suppliers^{3,44} → PES programs may offer participants access to information 	<ul style="list-style-type: none"> ↑ Use of and number of information sources informing farm management
Social capital (O) 5,10,12,15,16,22,23	<ul style="list-style-type: none"> → Cooperatives facilitate access to some MVCs³; Some buyers contract only with producer groups⁴⁴ → PES participation can improve connections to and support from organizations⁴⁰ 	<ul style="list-style-type: none"> ↑ Household participates in organization(s) ↑ Number of types of organization household involved with ↑ Trust in PES/dairy buyer ↑ Human and WB important in farm management

Adaptive Capacity Variable	Expected variable relationship with:	Indicator(s)
	<p>→ Participation in modern food value chains (MVC)</p> <p>→ Participation in payments for environmental services (PES)</p>	<p>↑ Expected relationship with adaptive capacity</p>
<p>Perceived ability to act and positive attitudes towards change (Ag)</p> <p>5,18,23,41,58</p>	<p>→ Farmers in MVCs may become locked into particular livelihood strategies³⁶</p> <p>→ PES contracts may lock farmers in to particular land uses²⁶</p>	<p>↑ Perceived freedom to choose livelihood</p> <p>↑ Perceived ease in changing farming practices, products and markets</p> <p>↓ Land use freedom seen as challenge in PES</p>
<p>Producer autonomy and participation in decision-making and negotiation (Ag)</p> <p>10,16,19,21,24,46,52</p>	<p>→ Farmers in MVC may have reduced negotiating and decision-making power^{28,34,51}</p> <p>→ PES programs tend to be dominated by intermediary program administrators who define program incentives and requirements^{38,57}</p>	<p>↑ Perceived ability to negotiate</p> <p>↑ Perceived independence in dairy market and PES transactions</p>

1. (Alam et al., 2016) 2. (Baca et al., 2014) 3. (Barrett et al., 2012) 4. (Bellemare, 2012) 5. (Bennett et al., 2014) 6. (Bloch et al., 2016) 7. (Börner et al., 2010) 8. (Boselie et al., 2003) 9. (Bouroncle et al., 2017) 10. (Breslow et al., 2016) 11. (Briones, 2015) 12. (Brown et al., 2010) 13. (Cabell and Oelofse, 2012) 14. (Chambers and Conway, 1992) 15. (Cinner et al., 2015) 16. (Cohen et al., 2016) 17. (Corbera et al., 2007b) 18. (Darnhofer et al., 2010) 19. (Deci and Ryan, 2000) 20. (Deressa et al., 2009) 21. (Diener et al., 2010) 22. (Dolan et al., 2008) 23. (Eakin et al., 2015) 24. (Engle and Lemos, 2010) 25. (Foley et al., 2011) 26. (German et al., 2010) 27. (Gomez et al., 2011) 28. (González and Nigh, 2005) 29. (Greiner and Stanley, 2013) 30. (Grieg-Gran et al., 2005) 31. (Hartmann, 2011) 32. (Hogarth and Wójcik, 2016) 33. (Holland et al., 2017) 34. (IFPRI, 2016) 35. (Jackson et al., 2010) 36. (Key and Runsten, 1999) 37. (Klasen et al., 2016) 38. (Kosoy and Corbera, 2010) 39. (Kremen et al., 2012) 40. (Locatelli et al., 2008) 41. (Lockwood et al., 2015) 42. (Mylan et al., 2015) 43. (Okello and Swinton, 2007) 44. (Otsuka et al., 2016) 45. (Pagiola et al., 2005) 46. (Park et al., 2012b) 47. (Power, 2010) 48. (Ramankutty et al., 2018) 49. (Reardon et al., 2001) 50. (Reardon et al., 2009) 51. (Rotz and Fraser, 2015) 52. (Ryan and Deci, 2006) 53. (Schwentenius and Gómez, 2008) 54. (Shaver et al., 2015) 55. (Summers et al., 2012) 56. (Ullah et al., 2015) 57. (Vatn, 2010) 58. (Welzel and Inglehart, 2010) 59. (Zanillo et al., 2015)

1.5 Dissertation overview

1.5.1 Case study: San Carlos, Costa Rica

Research questions in this dissertation were explored through a case study in Costa Rica.

Fieldwork was conducted from January to May 2014. Costa Rica was chosen as a focus country because it has one of the longest running payments for environmental services programs in the world – the Pagos por Servicios Ambientales (PSA) program run by the national government's Fondo Nacional de Financiamiento Forestal (FONAFIFO). Costa Rica is also part of Latin America, which saw some of the earliest food system transformation, meaning that it has many well-established modern food value chains. Similar patterns of transformation are now emerging in other regions of the world (Reardon et al., 2012), suggesting that Costa Rica may provide useful insights into understanding food system transformation elsewhere.

This study focuses on dairy cattle farmers and dairy food value chains. As a high value and highly perishable product, milk shares characteristics with other products like fresh fruits and vegetables that have engaged small scale farmers with relative success. Dairy farming commonly involves small and medium scale farmers in developing countries but is not widely explored in the value chain participation literature. This suggests that a dairy case study might provide complimentary understanding to the plethora of fresh fruit and vegetable studies in the literature. In Costa Rica, the dairy sector is also relatively less complicated than many other food sectors with modernized value chains. While there are dairy producer cooperatives, there were fewer potentially confounding variables, like third party certifications, compared to many other sectors that involve small scale producers, like coffee.

Dairy production is an important industry in Costa Rica; at the time of this study, it represented the third largest agricultural sector by value in the country (behind coffee and bananas), and provided more than 5% of the country's private sector employment (Madriz Carillo, 2014). Dos Pinos, a Costa Rican producer cooperative and multinational dairy (and as of recently, food) processing company, dominates the formal sector and captured 82% of market share in 2013 (Madriz Carillo, 2014). Around the time of this study, Sigma Alimentos, a Mexican multinational food processor, was in second place with 13% and Florida Lácteos, a division of Florida Ice & Farm Co., a Costa Rican multinational, was in third with 2% (Madriz Carillo, 2014). Dos Pinos, Sigma, and Florida are the controlling firms in the three modernized dairy value chains with suppliers based in San Carlos. Florida Lácteos is supplied by the Coopeleche cooperative, also based in San Carlos.

The “traditional” dairy sector in Costa Rica includes both formal and informal dairy production, and multiple different value chains. The informal sector involves farmers selling milk and cheese they produce on-farm to small local vendors, and directly to consumers on the street and at farm gate. The formal traditional sector involves farmers selling milk and cheese to small-scale local processors, to wholesalers and to middlemen supplying wholesalers. Processors sell cheese and sour cream to local retailers, consumers, and wholesalers. Some wholesalers supply more distant markets. Key differences of modern value chains versus formal traditional value chains are the spatial scale and volume of activity (with modern value chains tending to have greater spatial separation between value chain actors, particularly producers and consumers, and tending to have higher production), and the independence of value chain actors in the transaction (with formal traditional value chain actors generally having greater independence).

The PSA program in Costa Rica was created by a forestry law in 1996 as part of a multifaceted approach to address the rapid deforestation taking place in the country. It began operation in 1997, focused primarily on incentivizing forest conservation. Since its creation, the program has evolved to place increased emphasis on other modalities, including reforestation and agroforestry practices, on the delivery of social co-benefits, and on the inclusion of smaller-scale landowners (Porras et al., 2013). Via intermediary organizations and forestry engineers, FONAFIFO signs 5 to 15 year contracts with landowners to secure land uses understood to provide four bundled categories of ES: greenhouse gas mitigation, hydrological services, biodiversity protection, and scenic beauty (FONAFIFO, 2017a; Porras et al., 2013). Participants are chosen with consideration given to a suite of characteristics, including farm size (with preference given to smaller farms) and region (with preference given to ecologically valuable areas). In San Carlos, a sustainable forestry NGO, La Comisión de Desarrollo Forestal de San Carlos (CODEFORSA), is the primary PES facilitator connecting participants to FONAFIFO. Additional details about PES in Costa Rica can be found in Chapter 4 of this dissertation.

Our case study focused on the cantón of San Carlos in the province of Alejuela north of Costa Rica's capital, San José (Figure 1.4). This is a key dairying region in Costa Rica and has a relatively high rate of PES participation, including among dairy farmers. Some study participants are located just outside San Carlos, reflecting local understanding of regional boundaries that didn't always align with strict cantón borders.

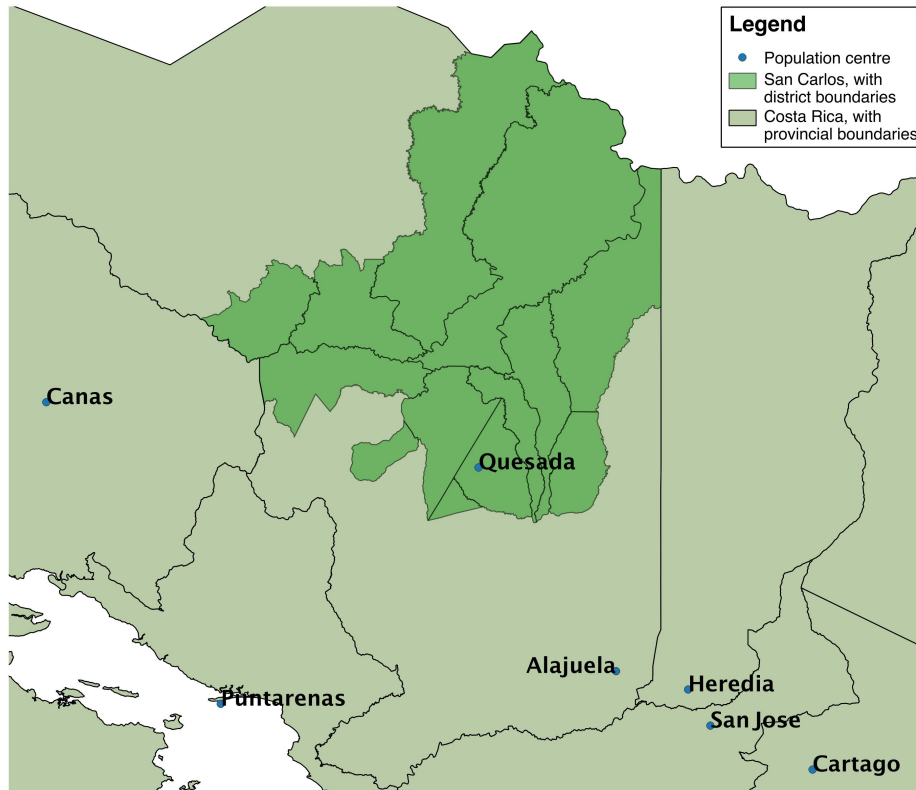


Figure 1.4 The cantón of San Carlos. The study was conducted in the southern half of the Cantón, within a two-hour drive of Quesada. Some study participants were located just outside the official Cantón boarder, reflecting the fact that local understanding of what constitutes the region of “San Carlos” did not always follow rigid Cantón boarders. Map was created in QGIS with data from Geotechnologias (2016), IDESCA (2017) and Natural Earth (2017).

In San Carlos, neither PES participants nor modern dairy value chain participants were regularly distributed across the cantón. PES participants tended to be concentrated closer to Ciudad Quesada, the cantón capital, where most PES intermediaries are based. Dairy farms selling into modern value chains were located along company collection routes, concentrated close to processing and collection centres. Dos Pinos was the largest operator. It had a processing facility in the regional centre, Quesada, and an extensive network of collection routes in the south of San Carlos. San Carlos accounted for about 60% of the company’s total national production. Sigma

Alimentos was the second largest player. Sigma had processing facilities in Monteverde (just outside San Carlos) and collection routes in the south-western part of the cantón. Florida Lácteos, a division of the Costa Rican multinational food processing and distribution company Florida Ice & Farm Company, was supplied by the Coopeleche cooperative and had a processing plant in San Ramon in the south of San Carlos. Farmers selling into traditional value chains, while more evenly dispersed than modernized value chain producer, nevertheless tended to concentrated closer to commercial centres where they could access markets and agricultural inputs and services. Farmers selling in traditional markets sold milk or cheese directly to consumers, to local retail outlets, to small local processors, or to merchants buying for more distant wholesalers. One of the regional processors supplied by San Carlos producers was owned and operated by the Coopebrisas producer cooperative.

Coopebrisas has characteristics of both modern and traditional supply chains. Like a modern supply chain, the Coopebrisas value chain is vertically integrated. Coopebrisas owns a processing plant that makes a variety of dairy products from their producer-members' milk that they market and sell to retailers in the region. The cooperative has high quality standards. However, like a traditional value chain, Coopebrisas still operated only regionally when this study was conducted, maintaining a much closer connection between producers and consumers. In this study, the number of Coopebrisas participants is small – only 6 of 217 survey respondents. As such, we expect their influence on the survey results to be small overall. With the exception of Chapter 5, Coopebrisas members were included with producers supplying traditional dairy value chains for analyses in this dissertation, as this is expected to be a conservative approach: i.e. where Coopebrisas members demonstrate characteristics of modern

value chain suppliers, their inclusion with traditional value chain suppliers will reduce the difference between modern and traditional suppliers. For the analyses for Chapter 5, the decision was made to include Coopebrisas suppliers with modern value chain suppliers because, like other modern value chain firms operating in San Carlos, Coopebrisas engages in corporate social responsibility practices, which might have had implications for the farming practices used by their suppliers.

Additional details about the Costa Rican dairy industry and dairy value chains operating in San Carlos can be found in Chapters 2, 3 and 5.

1.5.2 A mixed methods approach

This study combines qualitative and quantitative data and analysis. Quantitative data was collected via household surveys conducted on 217 cattle farms. Qualitative data was collected via semi-structured interviews with 20 key informants. This approach allowed me to capture detail at the focus scale of the study (the farm) as well as to build contextual understanding beyond the farm level.

The survey was designed to collect data about the suite of variables described in the wellbeing framework above, as well as demographic, dairy market, and PES data. I initially developed the survey in English, then translated it working closely with a bilingual native speaker with translation experience and knowledge of farming and rural areas to ensure that the text was translated with the intended meaning. Survey development benefited from explorations of dairy farming, dairy markets, and wellbeing concepts via focus groups, exploratory interviews, and

several informal meetings with dairy farmers in a dairying community near the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), an education and research institution that supported my field research. Survey development also benefited considerably from conversations and a formal interview with an agricultural extension worker in the region. For market participation questions, I consulted with a colleague who was conducting a market participation survey of fresh fruit and vegetable farmers in Nicaragua in the same year (Elder, 2016). Connections and insights from colleagues at CATIE with extensive experience conducting research with cattle farmers in Costa Rica significantly improved the quality of my research instruments, data collection, and analyses.

In San Carlos, I sought out survey respondents from farm households for which dairying was their primary agricultural income generating activity. Dairy farms were identified using annual government agricultural census data shared by the Servicio Nacional de Salud Animal (SENASA). PES participants were identified with data from CODEFORSA and FONEFIFO. In all cases, survey respondents participated in farming and represented the household responsible for primary decision-making and operation of the dairy farm businesses they operated. In the vast majority of cases, households represented in this study were both owners and operators. In a small number of cases, households surveyed were manager-operators who had long-term agreements to run dairy farms on behalf of spatially distant and disengaged farm owners. Owner-operators and manager-operators were considered together in this study because they had similar levels of responsibility for both day-to-day and longer-term business and farm planning and decision-making. Notably, this study did not include other types of workers involved in these

dairy farms, such as full-time employees and seasonal workers, and thus does not capture wellbeing effects for non-operator households.

Because most regional PES intermediaries were based in Quesada, and because modern dairy value chains were operating primarily in the south of the cantón, I limited participation to farms within a two-hour drive from Quesada aiming to both ensure sufficient PES participants in the sample, and to reduce the number of potential participants who did not have the option of supplying a modern value chain due to their geographic location.

Because neither PES participants nor dairy market suppliers are uniformly distributed in the region, I used multistage sampling to select dairy farms from regions centred on selected communities in San Carlos. I cross-referenced SENASA census data with PES data from FONAFIFO to identify dairy farmers participating in PES. To sample sufficient PES participants from a relatively small sub-population, I identified and included communities with high numbers of dairy farming PES participants. Dos Pinos, Sigma and Coopeleche were unwilling to share information about their suppliers and collection routes. Therefore, to sample farmers participating in a variety of dairy markets, I identified areas likely to be supplying different markets based on expert input and knowledge of the location of the collection and processing centres of different firms. I then created a list of sample areas with a high number of PES participants and representing an expected diversity of dairy value chains. Within these areas, PES participants were targeted to ensure sufficient representation in the sample. Other dairy farmers in the area were sampled randomly using data from SENASA. Where a target participant

could not be located, a suitable substitute was located from the SENASA list, or via snowball sampling where SENASA data was found to be inaccurate.

Survey data was collected during April and May 2013 by a team of university students studying agriculture at Tecnológico de Costa Rica (TEC) in San Carlos led by research assistants hired through CATIE. I trained students in survey methods. The survey was piloted in the region and reviewed by students and a professor at TEC who contributed valuable local knowledge of both the geography of San Carlos and of local farming culture and norms. Surveys were administered orally in person on participant farms, allowing surveyors to collect additional observational data, including notes and photos. I coordinated the survey and attended multiple surveys over the survey period, often asking additional questions to clarify and provide context to survey responses. Surveys took between 30 and 90 minutes to complete.

Survey data was entered in Microsoft Excel, then imported into R statistical software for analysis. A wealth index was calculated based on household and productive assets, using the first component from principal components analysis to weight assets (Filmer and Pritchett, 2001; Rutstein and Johnson, 2004). Wealth indices have been demonstrated to be useful proxies of wealth and long-term economic wellbeing for developing country households (Filmer and Pritchett, 2001; McKenzie, 2005; Michelson et al., 2013; Rutstein and Johnson, 2004). Where recall bias is expected and/or accurate income data are difficult to obtain, wealth indices can be preferable (McKenzie, 2005; Michelson et al., 2013; Rutstein and Johnson, 2004; Sahn and Stifel, 2000). More information about the wealth index and its construction can be found in the methods section of Chapter 4.

Statistical analyses included group comparisons using proportion test, Fisher tests, t-tests and Wilcoxon tests, and linear and logistic regressions. Details about individual analyses are included in the methods sections of each chapter.

A semi-structured interview protocol was developed to collect data about dairy value chains and the Costa Rican PES. Interviews solicited information about the relationships between actors, the movement of products and money, and perceptions of benefits and challenges. The framework of the interview was inspired by the mental modelling approach described by Morgan et al. (2002), aimed at soliciting how interviewees understood dairy value chains and PES and the roles and relationships of people and entities engaged in and influencing these activities. The interview protocol was initially developed in English, and then translated in collaboration with a native speaker with translation experience. The protocol benefited from feedback from colleagues at CATIE and from exploratory focus groups, interviews and question piloting with dairy farmers near CATIE.

Interviews were conducted from March to May 2014 in person where possible, as well as by Skype and by phone. Interviews were conducted in Spanish or English by myself and by trained research assistants from CATIE and TEC. Where logistically possible, I aimed to have a research assistant lead interviews in Spanish while I listened, allowing the interview to proceed more smoothly between two native speakers while giving me the opportunity to experience a participant's replies first hand, and interject with my own questions. Key informants included five cattle and dairy industry representatives, two agricultural extension workers, the director of

FONAFIFO's PES program, three regional PES facilitators (individuals and organizations who connect PES participants to FONAFIFO), and ten producers identified as "community leaders" by agricultural extension workers and follow producers. Producer key informants included both PES participants and non-participants, and represented a diversity of dairy farming experiences with respect to markets, farm size, farming practices, location, etc.

Interview recordings were transcribed by native Spanish speakers. I worked with interview transcripts in Spanish, consulting with Latin American colleagues on questions of interpretation and meaning. Qualitative methods were used to inductively identify, organize, and summarize themes and ideas in the interviews (Thomas, 2016). Additional details can be found in the methods sections of individual chapters.

For each analysis, I brought together quantitative and qualitative results. Statistical analysis primarily demonstrated correlations between participation in modern value chains or PES and various wellbeing indicators. In analyses focusing on quantitative results, hypotheses about the causal directions and reasons for observed correlations were developed using a combination of insights from other statistical findings from the survey, qualitative data, knowledge about the field site and case study, and the literature. Similarly, in analyses focusing on qualitative results (primarily Chapter 3), statistical correlations and trends in survey data are used to support qualitative findings and generate hypotheses.

1.5.3 Chapter overviews

This dissertation includes four data chapters (2 to 5). Using data from my Costa Rican case study, each chapter contributes to understanding how and why participation in modern coordinated value chains – dairy and/or PES – links to wellbeing, broadly conceived. Each chapter was written with the intent to publish in a peer-reviewed journal as a stand-alone paper with my supervisors as co-authors; as such, these chapters are written in the first-person plural, and there is some repetition in the description of methods and study context. The following paragraphs summarize the dissertation chapters, identifying gaps in the literature that I attempt to address in each.

Chapter 2 goes beyond common narrow explorations of wellbeing in market participation studies to explore future wellbeing, represented by adaptive capacity, in relation to dairy market participation. In only considering one or a few indicators of wellbeing, and in focusing on the present, most market participation studies do not capture the diverse implications of modern value chains for producer wellbeing. This study contributes to addressing this gap. Using statistical analysis supported by qualitative data, this chapter describes how indicators of adaptive capacity link to participation in traditional versus modernized dairy value chains, both by facilitating access to market opportunities and via the effect of participation on these indicators.

Chapter 3 contributes to understanding how the functioning of modern coordinated value chains affects producer wellbeing. Most market participation studies considering producer wellbeing focus on the effects of formal value chain structures like standards and contracts; informal value

chain characteristics are rarely considered, and generally poorly understood. Chapter 3 addresses this gap by highlighting how informal characteristics can influence outcomes. Contrasting the unusual case of Dos Pinos, a cooperative multinational firm, with other modern dairy value chains in San Carlos, this chapter combines qualitative and quantitative analyses to develop hypotheses about how firm approaches to supplier relationships in modern value chains determine producer experiences and wellbeing both inside and outside these value chains.

Chapter 4 explores producer participation and wellbeing in relation to PES. Like Chapter 2, this chapter also takes a broad approach to wellbeing and presents a more nuanced understanding of the relationships between PES participation and human wellbeing than is generally possible with the more narrow approaches to wellbeing often taken in the PES literature. Using statistical analysis with qualitative data, this chapter describes some similar patterns to Chapter 2. At the same time, this chapter highlights the apparent importance of non-material benefits in motivating PES participation, which underpins suggestions for how PES might be reconceptualised to harness non-monetary motivations and environmental values.

Chapter 5 investigates links between environmental aspects of wellbeing and participation in modern food value chains and PES, using farming practices as a proxy for environmental effects. Environmental effects are treated considerably less often than human wellbeing in the market participation literature. In the PES literature, evaluations of environmental performance are usually limited to the specific ES targeted by a PES program. Given the importance of agricultural sustainability to human and environmental wellbeing, links between participation and agricultural practices are arguably important, yet have not been widely considered. This

chapter uses statistical analysis supported by qualitative data to examine how the use of sustainable farming practices connects to participation in PES and in different dairy value chains. This chapter highlights the apparent importance of primary livelihood activities – and modern food value chains in particular – in influencing environmental practices and initiates a conversation about how PES might be integrated into modern food value chains to increase their impact.

The dissertation conclusion discusses the major contributions of this research by bringing together findings from the four data chapters. It reflects on contributions of the dissertation to understanding of participation in modern food value chains and PES in light of a broad approach to wellbeing. It also reflects on the broader question of whether and how it might be useful to consider PES and modern food value chains together. Strengths and limitations of this research are detailed. The dissertation concludes with ideas for future exploration.

Chapter 2: Constraining choices or opening doors? An adaptive capacity lens on dairy market participation in Costa Rica

2.1 Introduction

Food systems are becoming increasingly globalized and modernized resulting in agricultural value chains that are more vertically coordinated, with a single intermediary firm controlling many steps along the chain from producer to consumer (Barrett et al., 2012; Busch and Bain, 2004; Otsuka et al., 2016; Reardon and Barrett, 2000; Wang et al., 2014). Contracting is a pervasive mechanism of vertical coordination in agricultural value chains (Okello and Swinton, 2007). For producers, participation in modernized food value chains can offer both new opportunities and challenges. It can allow them to access new markets, training opportunities, inputs and technology, and can provide the potential for increased income and stability (Barrett et al., 2012; Minten et al., 2009; Otsuka et al., 2016; Ruben and Sáenz, 2008; Van der Meer, 2006). At the same time, modernized value chains can present new challenges, including strict quality and quantity requirements and delayed payments (Barrett et al., 2012; Lee et al., 2012; Schwentesius and Gómez, 2008; Soper, 2015).

Participation in modernized markets is increasingly presented as a viable, desirable and even necessary strategy for development by researchers, organizations and governments (e.g., Barrett et al., 2012; Helmsing and Vellema, 2011; IFPRI, 2016; Slingerland et al., 2006; Taglioni and Winkler, 2014; USAID, 2016; Weatherspoon and Reardon, 2003). Increased income is frequently presented as both a primary motivation for promoting participation in modernized

agricultural value chains, and as an indication of improved human wellbeing (measured in economic terms) as a result (e.g., Barrett et al., 2012; Bellemare, 2012; Otsuka et al., 2016). Yet, human wellbeing is understood to encompass much more than income and material possessions, including a diversity of factors like health, social involvement, and life satisfaction (Chambers, 1997; Dolan et al., 2008; Gasper, 2004). When a broader approach to wellbeing is taken, the picture becomes more complicated.

A lack of consideration of future wellbeing in the market participation literature is also particularly concerning. The term wellbeing is commonly used to reflect the perceptions and assets people have in the present. Future wellbeing depends on factors that allow an individual or group to sustain or secure wellbeing in the face of future changes or stresses. This idea is largely captured by the concept of adaptive capacity, which is understood to be influenced by factors connected to current wellbeing, like assets, but also to factors related to the capacity to mobilize resources to respond to change, like access to additional resources (e.g. credit), learning, flexibility, and agency (see Section 2.2).

Adaptive capacity is arguably a key consideration with respect to modern market participation for two main reasons. First, current food systems are characterized by change; beyond the changes in value chains described above, food systems are also changing as a result of influences that include market fluctuations, agricultural mechanization and intensification, a growing population of urban consumers, and rapid climate change (Chapman et al., 2017; Ericksen, 2008). This means that wellbeing benefits will only be sustained if producers are able to cope and adapt in the face of these changes. Second, concerns have been raised that participation in

modernized value chains could reduce both producer negotiation power and flexibility in livelihood strategy and farm management decisions (González and Nigh, 2005; IFPRI, 2016; Klasen et al., 2016; Reardon and Barrett, 2000; Shaver et al., 2015), two factors thought to be important to adaptive capacity. Yet, the concept is largely absent from market participation research, particularly with respect to modernized value chains. A notable exception is Holland et al. (2017), who found evidence that commercial coffee farmers in Costa Rica had higher adaptive capacity than subsistence farmers.

In a case study of dairy market participation in Costa Rica, we conducted household surveys and key informant interviews to explore a broad set of variables relevant to producer wellbeing. In this paper, we use an adaptive capacity lens to explore the implications of modern market participation. Section 2.2 presents an overview of the adaptive capacity concept and our analysis framework. Section 2.3 describes our case study site and methods. In Section 2.4, we present our results, and discuss them in light of expected benefits and concerns when farmers participate in modernized food value chains. Section 2.5 concludes with suggestions to guide future research.

2.2 An adaptive capacity lens on market participation

Adaptive capacity is broadly understood to be a dynamic, multifaceted and favourable property of system actors that allows the achievement of a desirable state in the face of stress or change, through a combination of processes that include coping with consequences and taking advantage of opportunities (Engle, 2011; Gallopin, 2006; IPCC, 2007; Smit and Wandel, 2006). While different theoretical approaches have been taken to framing adaptive capacity, there is general agreement that the concept is applicable at different scales, and also influenced by contextual

factors, such as institutions and governance, across scales (Adger et al., 2016; Bennett et al., 2014; Gallopin, 2006). Some researchers distinguish between general and specific adaptive capacity (factors that facilitate adaptation to most stresses, versus factors that facilitate adaptation to specific stresses) (Eakin et al., 2014; IPCC, 2007; Lemos et al., 2016), and incremental versus transformative adaptation (Park et al., 2012b). Increasingly, it is recognized that adaptation occurs in response to multiple concurrent stressors (O'Brien et al., 2004).

In market participation research, the term adaptive capacity is not often used. Where it has been used, it has been applied mainly to understanding climate change adaptation in agricultural settings and to understanding development pathways (with overlaps between the two). In general, adaptive capacity research in agricultural settings is frequently framed in the context of adaptation to climate change (e.g., Bloch et al., 2016; Hogarth and Wójcik, 2016; Holland et al., 2017), a key stressor for developing country producers (Cohn et al., 2017; Fankhauser and McDermott, 2014; Lipper et al., 2014). Less-discussed potential stressors for farmers include price changes and market shocks (connected to both farm inputs and farm products), disease and pest outbreaks, and environmental degradation (Darnhofer et al., 2010; Holland et al., 2017; Howden et al., 2007; Tucker et al., 2010). Factors understood theoretically or empirically to contribute to adaptive capacity in agricultural contexts include access to resources like monetary and material assets (particularly land) and credit (Brown et al., 2010; Cohen et al., 2016; Hogarth and Wójcik, 2016; Holland et al., 2017; Lemos et al., 2016); livelihood and income flexibility and diversity (Bloch et al., 2016; Brown et al., 2010; Darnhofer et al., 2010; Holland et al., 2017; Mijatović et al., 2013); education, experience, and information (Alam et al., 2016; Brown et al., 2010; Cohen et al., 2016; Hogarth and Wójcik, 2016; Ullah et al., 2015); technology and inputs

(Hogarth and Wójcik, 2016); social capital (Bloch et al., 2016; Brown et al., 2010; Cohen et al., 2016); the quality and care of the natural resource base (Brown et al., 2010; Hogarth and Wójcik, 2016; Holland et al., 2017); and farmer perceptions and attitudes around risk, learning and change (Darnhofer et al., 2016; Eakin et al., 2015; Lockwood et al., 2015; Mase et al., 2017).

Adaptive capacity has also been widely applied in a development context, where it has been argued that adaptive capacity is a social justice concern and should be a priority for sustainable development (Adger et al., 2016; Engle, 2011; Folke et al., 2002). Many of the concerns raised in the rural development literature with respect to producer participation in modernized value chains can be linked to common components of adaptive capacity. Concerns that participants in modernized markets might become locked in to particular livelihood strategies if they reduce their production and market diversity (Klasen et al., 2016), concentrate effort and investment in a single livelihood activity (Stoian et al., 2012), and restrict flexibility via contracts (Key and Runsten, 1999) are linked to a farm household's flexibility and ability to switch between livelihood activities and farm products in response to stresses. Concerns that powerful firms dominate modernized value chains and reduce producer decision-making power (IFPRI, 2016) are connected to a farmer's agency and ability to determine outcomes from their livelihood activities.

In addition, access to modernized markets may also be associated with factors associated with higher adaptive capacity. Given the high initial investment and managerial skills often required to participate in modernized markets, producers generally need a minimum level of resource access to be able to participate (IFPRI, 2016; Stoian et al., 2012). Several factors understood to

contribute to adaptive capacity, like access to assets, information, and education, also appear to facilitate access to modernized markets in many cases (Boselie et al., 2003; IFPRI, 2016; Reardon et al., 2009; 2001).

In the literature, adaptive capacity is usually framed using one of two broad approaches: conceptualizing adaptive capacity as a component of vulnerability; and conceptualizing adaptive capacity in the context of social-ecological systems resilience (Engle, 2011; Gallopin, 2006). Vulnerability research commonly frames adaptive capacity as a characteristic that combines with risk to determine vulnerability, and focuses on specific threats and hazards, like climate change (e.g., Adger, 2006; Baca et al., 2014; IPCC, 2007). Resilience approaches view adaptive capacity as the ability of system actors to manage the system and its response to change, and emphasize the importance of uncertainty and system interactions (e.g., Cinner et al., 2009; Darnhofer et al., 2010; Walker et al., 2004). Increasingly, researchers are identifying commonality across these approaches and are understanding them to be linked (e.g., Berman et al., 2012; Gallopin, 2006; Park et al., 2012b).

Adaptive capacity can be difficult to operationalize (Engle, 2011; Hinkel, 2011), in part because factors that contribute to adaptive capacity can vary considerably with demographic characteristics, scale, context and for specific stressors (Cinner et al., 2015; Cohen et al., 2016; Eakin et al., 2014; IPCC, 2007; Marshall et al., 2009; Smit and Wandel, 2006). However, a review of the literature reveals considerable commonality in the factors understood to contribute to adaptive capacity across different theoretical framings, and across a variety of cases and contexts. Although there is some fluidity in the categorization of these components of adaptive

capacity, most researchers organize components into similar sets of broad categories. One common set of categories, often used with a vulnerability framing of adaptive capacity, builds on a livelihood capitals framework, and distinguishes different types of assets and capabilities, like social, human, natural, etc. (e.g., Brown et al., 2010; Hogarth and Wójcik, 2016; Holland et al., 2017; Lockwood et al., 2015). Resilience framings more often use categories that reflect different paths via which components are thought to facilitate adaptive capacity, for example via access to assets, flexibility, institutional context, etc. (e.g., Bennett et al., 2014; Cinner et al., 2009; Cohen et al., 2016).

For this study, we take the latter approach, based on the categories of Bennett et al. (2014) and Cohen et al. (2016). This framing more closely reflects the broad types of influence we hypothesize market participation to have on adaptive capacity. Drawing on our literature review, we selected and categorized a subset of adaptive capacity components that we expect to be relevant to modernized value chain participation at the farm level (Table 2.1). From our review, we expect that many of the components in our analysis can contribute to general adaptive capacity in an agricultural context, primarily via making a greater number and variety of options available to producers when they respond to change (Darnhofer et al., 2010; IPCC, 2007).

Notably, while many adaptive capacity frameworks include consideration of governance and political context, we did not include these dimensions. In the interest of limiting the time commitments required of survey participants, we focused on factors expected to be most likely to vary with value chain participation. Given that we were studying farmers living in the same region and fulfilling similar roles on their farms (i.e. farm managers and/or owners), we expected

less variation in political and governance factors than other factors. Questions asked in semi-structured interviews confirmed that this was likely the case in the study region.

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Table 2.1 Adaptive capacity framework for exploring participation in modernized markets. Categories are adapted from Bennett et al. (2014) and Cohen et al. (2016).

Category	Component	Indicator	Expected relationship with adaptive capacity (AC) ↑ Indicator effect on AC	Expected relationship to modernized market (MM) participation ↑ Indicator effect on MM participation ↑ Effect of MM participation on indicator
Access to Assets	Wealth and non-monetary assets ^{5,10,12}	Wealth Index	↑ 5,11	↑ Greater wealth facilitates MM participation ^{9,30} ↑ Higher prices in MM may increase wealth ^{3,4,27,30}
	Technology ^{18,19,24}	Use of inputs: Herbicides, Pesticides, Fertilizers, and/or Hormones	↑ 18,19	↑ Facilitates meeting quantity and quality requirements in MM ↑ Some MM intermediaries provide access to inputs for their suppliers ³
		Use of computer, internet, email	↑ 2	↑ Facilitates organization and access to information, which facilitates market access ^{7,20,30,31}

Category	Component	Indicator	Expected relationship with adaptive capacity (AC) ↑ Indicator effect on AC	Expected relationship to modernized market (MM) participation ↑ Indicator effect on MM participation ↑ Effect of MM participation on indicator
	Credit and subsidies ^{5,10,11,19}	Access to credit	↑ 5,8,11	↑ Facilitates investment to meet MM standards ³¹ ↑ Some MM intermediaries provide access to credit for their suppliers ^{3,27}
	Access to non-monetary support e.g., agricultural extension services ^{8,14,28}	Receive non-monetary support	↑ 8,14,28	↑ Can facilitate market access ^{2,31} ↑ Some MM intermediaries provide access to services like technical and veterinary support ^{3,27}
Flexibility and Diversity	Livelihood and income diversity and flexibility ^{5,10,11,15,19}	Household has off-farm income	↑ 8,14	↑ Access to stable non-farm income could make switching to MM easier
		Number of HH income streams, number of farm products	↑ 5,11,19	↓ Specialization to sell to MM leads to reductions in different income streams ²²

Category	Component	Indicator	Expected relationship with adaptive capacity (AC) ↑ Indicator effect on AC	Expected relationship to modernized market (MM) participation ↑ Indicator effect on MM participation ↑ Effect of MM participation on indicator
		Farm has contract (or cooperative agreement) with buyer	↑ Can lock farmers into livelihood/farming strategies ²² ↓ Can provide stability by securing prices and market access ^{3,27}	↑ Contracts common method of vertical coordination in MM ²⁶
	On-farm diversity ^{6,13}	Farm varies products, land uses, cattle varieties*	↑ 6,13,26	↓ Specialization to sell in MM leads to reductions in farm diversity ³²
Learning and Knowledge	Experience ^{13,18}	Years as cattle farmer and farming current land	↑ 16,28,33	↑ Experience might facilitate ability to participate in MM ⁴
	Education ^{5,10,12}	Education level and access to training	↑ 2,18,28	↑ Education and training can facilitate access to MM, though not always ^{27,29,30} ↑ Some MM intermediaries offer suppliers access to training opportunities ^{3,27}

Category	Component	Indicator	Expected relationship with adaptive capacity (AC) ↑ Indicator effect on AC	Expected relationship to modernized market (MM) participation ↑ Indicator effect on MM participation ↑ Effect of MM participation on indicator
	Access to information ^{1,12,18,20}	Use of and number of information sources informing farm management	↑ 2,5	↑ Use of information for farm management and ability to navigate information sources could facilitate meeting MM standards ²⁰ ↑ Some MM intermediary buyers facilitate access to information for suppliers ^{3,27}
Capacity to Organize	Social capital ^{5,10,11,12}	Organization involvement	↑ 2,11,15	↑ Cooperatives facilitate access to some MMs ³ ↑ Some buyers contract only with producer groups ²⁷
Agency	Perceived ability to act and attitudes towards change ^{5,13,15,23}	Perceived freedom to choose livelihood	↑ 13,15	↓ Farmers in MM may become locked into particular livelihood strategies ²¹
		Perceived ease in changing farming practices, products and markets	↑ 13,15,23	↓ Farmers in MM may become locked into particular livelihood strategies ²¹

Category	Component	Indicator	Expected relationship with adaptive capacity (AC) ↑ Indicator effect on AC	Expected relationship to modernized market (MM) participation ↑ Indicator effect on MM participation ↑ Effect of MM participation on indicator
	Participation in decision-making and negotiation ^{12,16,28}	Perceived ability to negotiate and independence in market	↑ 12,16	↓ Farmers in MM may lose power and ability to negotiate ^{17,20}

* For ease of comprehension in our survey, questions about these indicators were asked in reverse (i.e. rather than “Do you produce different products on your farm each year?”, we asked “Do you produce the same products on your farm every year?”). For clarity in this table, we have presented the reverse characterization of this indicator, as it is usually discussed in the AC literature.

Table references: (1) Alam et al. 2016; (2) Baca et al. 2014; (3) Barrett et al. 2012; (4) Bellemare 2012; (5) Bennett et al. 2014; (6) Bloch et al. 2016; (7) Boselie et al. 2003; (8) Bouroncle et al. 2017; (9) Briones 2015; (10) Brown et al. 2010; (11) Cinner et al. 2015; (12) Cohen et al. 2016; (13) Darnhofer et al. 2010; (14) Deressa et al. 2009; (15) Eakin et al. 2015; (16) Engle and Lemos 2010; (17) González and Nigh 2005; (18) Hogarth and Wójcik 2016; (19) Holland et al. 2017; (20) IFPRI 2016; (21) Key and Runsten 1999; (22) Klasen et al. 2016; (23) Lockwood et al. 2015; (24) Marshall et al. 2009; (25) Mijatovic et al. 2013; (26) Okello and Swinton 2007; (27) Otsuka et al. 2016; (28) Park et al. 2012; (29) Reardon et al. 2001; (30) Reardon et al. 2009; (31) Schwentesius and Gómez 2002; (32) Shaver et al. 2015; (33) Ullah et al. 2015

2.3 Methods

2.3.1 Case study: Dairy farmers in San Carlos, Costa Rica

We chose to study the dairy sector in Costa Rica for three main reasons. First, dairying in Costa Rica involves a mix of small, medium, and large-scale farms that participate in a mixture of modernized and traditional value chains. This diversity provides variation on several key parameters of interest. Second, there were fewer potentially confounding factors in the sector, like third party certifications, compared to other common case study sectors, like coffee. Finally, dairy has been highlighted as a sector in which it is thought that small-scale farmers can successfully participate in globalized markets (Reardon et al., 2009).

The Cámara Nacional de Productores de Leche (Madriz Carillo, 2014) and the federal Ministerio de Economía, Industria y Comercio (Muñoz and Zamora, 2013) characterized the dairy industry at the time of our study as follows. In 2012, dairy was the third largest agricultural sector in Costa Rica, responsible for over 11% of national agricultural production value. The sector was growing at a rate of about 4% per year, with dairy export becoming increasingly important. About 65% of dairy farms produced both dairy and meat products (known as “*doble propósito*” farms), while about 35% specialized in dairy only. About 40% of milk produced was sold in the informal sector as either milk or cheese (produced on-farm), while about 60% was sold in the formal industrial sector.

The formal industrial sector is dominated by Dos Pinos (Figure 2.1), a dairy processing, distribution and export company that began as a producer cooperative in 1947. Dos Pinos remains a producer cooperative with 1300 members, but now also has 2600 employees involved

in production, distribution, marketing and export (Dos Pinos 2018). Sigma Alimentos, a Mexican food processing and distribution company, secured the second largest share of the country's dairy sector starting in 2013, when they purchased regional processing company Monteverde. Florida Bebidas, part of Florida Ice & Farm Co., a large Costa Rican food processing company, was third in the dairy sector, with the remainder made up of several small regional processors. The value chains involving Dos Pinos, Sigma and Florida Bebidas can be characterized as modernized value chains. All three firms have significant control over the value chain and the terms of producer engagement.

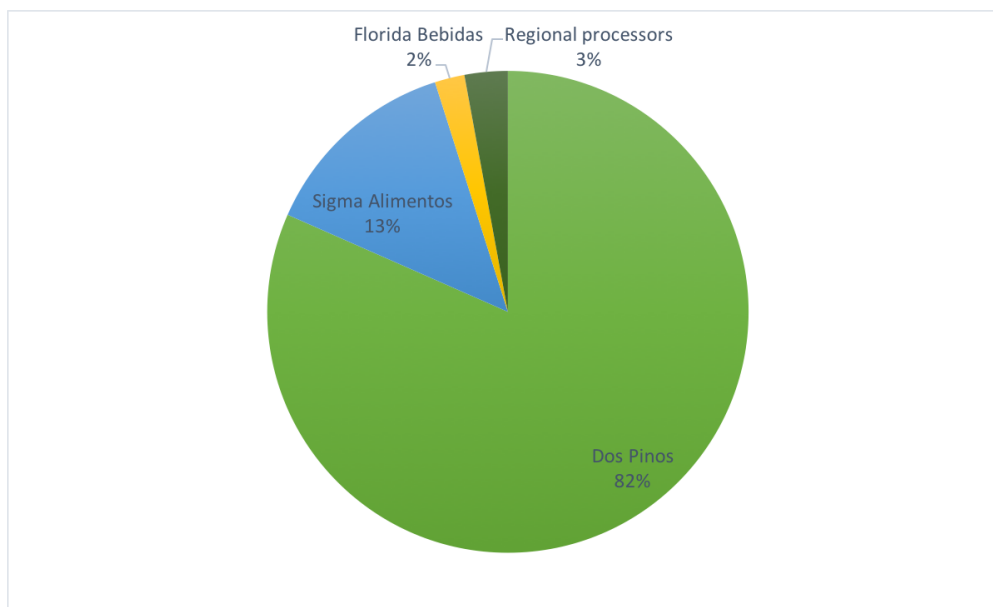


Figure 2.1 Percent market share of major processing companies operating in the Costa Rican dairy sector in 2013. Adapted from Madriz Carillo (2014).

This study was conducted in the cantón of San Carlos (Figure 1.4), a nationally important dairying region north of San José that is home to over one quarter of Costa Rica's dairy cattle (INEC, 2015). Farms closer to the main commercial centre, Quesada, where the climate is cooler

and wetter, tended to be dairy specialist farms, while farms further north and west where the climate is hotter and drier were more likely to be *dobles propósitos* (dual purpose) farms (for a more detailed classification of dairy farm types in Costa Rica, please see Vargas-Leitón et al. (2013)). Dos Pinos has a production facility in Ciudad Quesada (the commercial centre in the region) and is the dominant buyer for farmers closer to the city, particularly larger farms.

Coopeleche, a cooperative supplying Florida Bebidas, also has a presence in the south of the cantón. Sigma Alimentos has collection routes in the south-west of the cantón. Coopebrisas is a producer cooperative in the south-east that runs their own small-scale processing and distribution facility supplying milk and a limited number of dairy products to retail stores in the region. The geographic distribution of large dairy processing companies means most producers in San Carlos who wish to sell into a modernized value chain find themselves in a monopsony situation, where there is only one large-scale buyer operating in their area.

2.3.2 Sampling and data collection

We used multistage sampling to survey 207 dairy farms in southern San Carlos communities within a two-hour drive of Quesada. Of these, 64% were selling into modernized value chains and 32% were selling milk or cheese in traditional markets (Table 2.2). Additional details about sampling and data collection can be found in Chapter 1 of this dissertation.

Table 2.2 Number of survey participants selling into different dairy markets in 2014. Private companies controlling modernized, coordinated value chains include Sigma Alimentos and Florida Bebidas.

Dairy Market	Number of survey participants
Modernized:	
Dos Pinos	111
Private company	23
Traditional:	
Regional processor	6
Local/Informal	67

Surveys collected information about the household, farming practices, dairy market participation, conservation practices, conservation program participation, and indicators of wellbeing and adaptive capacity. Chapter 1 provides more details about the wellbeing and adaptive capacity variables and indicators explored in this study.

2.3.3 Adaptive capacity variables and analysis

Statistical analysis of survey data was performed using R software. We first constructed an asset-based Wealth Index as a proxy for wealth. More information about the construction of the Wealth Index can be found in Chapters 1 and 4 of this dissertation.

A subset of indicators of adaptive capacity was chosen for this analysis (Table 2.1). We chose indicators we expected to be linked to modernized market participation, either by facilitating participation and/or by being changed by market participation, and indicators that reflect concerns about farmer participation in modernized value chains from the literature (see Section 2.2). While there is evidence that having access to more resources is not universally associated with having better access to modernized markets (Barrett et al., 2012; Otsuka et al., 2016), we expect that this is likely the case in dairy markets in San Carlos because of the very high level of

investment farmers described to purchase required refrigerated storage tanks, equipment to meet quality and sanitation requirements, and shares in the cooperative (in the cases of Dos Pinos and Coopeleche/Florida Bebidas).

To explore the relationships between modernized market participation and chosen indicators of adaptive capacity, we compared dairy farmers selling in modernized markets to those selling in traditional markets. We used proportion tests to compare proportions for binary variables, substituting a Fisher test when any cell count was less than 10. We used t-tests to compare means for continuous variables, substituting a Wilcoxon test to compare sample shape for non-normal distributions. P-values were adjusted using the Benjamini Hochberg method to control the False Discovery Rate across multiple tests (Benjamini & Hochberg, 1995; Benjamini & Hochberg, 2000; Krzywinski & Altman, 2014).

To further explore the relationships between modernized market participation and adaptive capacity indicators, we ran a series of regression analyses. First, to examine what adaptive capacity indicators were most strongly correlated with participation in modernized markets, we ran a logistic regression with modernized market participation as the binary dependent variable, and multiple adaptive capacity indicators as independent variables.

Then, to explore how participating in modernized markets may be affecting adaptive capacity while controlling for other potentially important factors, we ran multiple regressions, each with a different adaptive capacity indicator as the dependent variable and modern market participation as the independent variable. Adaptive capacity indicators we hypothesized might be increased by

modernized value chain participation were: wealth, chemical fertilizer use, credit, number of information sources consulted to inform farm management, whether the household head had completed high school, and internet use. Linear regression was used to predict continuous variables; logistic regression was used to predict binary and count variables, using binomial and Poisson distributions respectively. We also included several control variables in our base models, based on the literature.

We reduced multicollinearity in all of our regression models by starting with our base models, and then using stepwise removal of variables with the highest variance inflation factor (VIF) until all model terms had a VIF less than 2 (Zuur et al., 2009). We then chose a final model by comparing models based on Akaike information criterion (AIC), delta AIC and Akaike weights (Akaike, 1992; 1981; Burnham and Anderson, 2004).

Statistical analysis revealed significant correlations between modernized market participation and adaptive capacity indicators. Because we were unable to establish causality, we combined statistical analysis with qualitative analysis from our case study and insights from the literature to present hypotheses about causal relationships. Qualitative data in this case study was collected at multiple meetings with key informants in the Costa Rican dairy and export sectors, exploratory focus groups and interviews with dairy producers, and 16 formal semi-structured interviews with key informants involved in the dairy industry (including both farmers and dairy company representatives) and government agricultural services provision. Key informant producers were “community leaders” identified by regional agricultural extension workers and fellow producers, and represented diverse dairy farming experiences. Where conclusions are presented in the

following sections, they rest on a triangulation of understanding built on statistical correlation, qualitative analysis, and the literature.

2.4 Results and discussion

2.4.1 Market participation, farm diversity, livelihood flexibility and farmer agency

We did not find evidence to support concerns in the literature that modern market farmers are more likely to specialize and have less farm diversity. Modernized market farmers did not have a significantly higher average proportion of their total cattle herd being milked (suggesting they were no more likely to have specialized dairy, versus dual purpose, farms). They were also no more likely than farms selling in traditional markets to produce the same products and have the same cattle varieties and land uses on their farms year to year. In fact, households selling in modernized markets had significantly more farm products and household income streams than those selling in traditional markets (Table 2.3).

We found some evidence supporting concerns that producers become locked in when they participate in modernized value chains. As expected, a majority of modernized market farmers (93.5%) had written contracts (or cooperative membership agreements that effectively functioned as contracts by specifying a supply quantity and exclusive supply relationship), compared to 6% in other markets. Modernized dairy market farmers perceived changing their dairy market to be significantly more difficult than traditional market farmers (Table 2.3). This suggests that those selling in modernized markets had less flexibility in their market choices and less flexibility to change markets in response to stresses, at least in the immediate term.

Contracts were not the only constraint on market choice identified by farmers. Those on larger farms supplying modernized markets explained that because a farm must be located on or near existing collection routes to sell to large buyers, and because Sigma and Dos Pinos have processing plants and routes in different regions of San Carlos, market options were effectively limited for large farms (those producing more than they could feasibly sell locally) to whichever large company was operating in their region. Modernized farmers may have felt further constrained if higher quality standards in their value chain (and hence, production costs) combined with higher prices to mean that they couldn't actually make satisfactory margins selling their milk outside of their contracted market (Barrett et al., 2012). This is plausible given that Dos Pinos farmers in particular repeatedly mentioned the cooperative's very high quality standards.

Table 2.3 Median indicators of livelihood diversity and farmer agency in modernized versus traditional dairy value chains in San Carlos.

Indicator	Test	Modernized dairy market farmers (median) (N=134)	Traditional dairy market farmers (median) (N=73)	95% Confidence Interval For difference between medians	Significance[†]
Perceived difficulty changing farm practices [‡]	Wilcoxon	1.8	1.6	(-3.6x10 ⁻⁶ , 4.8x10 ⁻⁵)	
Perceived difficulty changing farm products [‡]	Wilcoxon	1.6	1.5	(-6.2x10 ⁻⁵ , 4.4x10 ⁻⁶)	
Perceived difficulty changing dairy markets [‡]	Wilcoxon	1.5	1.8	(-6.9x10 ⁻⁵ , -3.6x10 ⁻⁵)	**
Number of household income sources	Wilcoxon	2.5	2	(3.7x10 ⁻⁵ , -0.10)	***
Number of farm products	Wilcoxon	1.8	1.5	(6.6x10 ⁻⁵ , -0.10)	***

[†] Based on p-values adjusted with Benjamini-Hochberg correction

* p<0.05 ** p<0.01 *** p<0.001

[‡] Responses to “perceived difficulty” questions were on a three-point Likert scale, ranging from 1 “very difficult to change” through to 3 “easy to change”

However, modernized market farmers were not more constrained across all farming and livelihood choices. Farmers in all dairy markets perceived similar levels of difficulty in changing their farm management practices and farm products (Table 2.3). In the case of farm products, we expect this was in part because of the nature of the dairy sector. Almost all dairy farms selling

commercially had already invested heavily in equipment; almost all farms had a milking machine, and most had invested in refrigerated storage and/or cheese making equipment. Cattle herds were also specialized to produce each farm's particular product mix (milk, or a specific mix of meat and milk), which would have made switching products expensive and undesirable. In the case of farming practices, farmers explained that their decisions were constrained, particularly for those selling in coordinated markets, by high quality and quantity requirements. For more resource-constrained producers, their choices of farming practices were often constrained by resources and access to inputs.

Overall, there was no significant difference between modernized and traditional markets in the proportion of farmers who agreed with the statement "I have complete liberty to determine how I make a living." This suggests that, despite likely being choice-constrained in some ways, modernized market farmers still felt like they had agency in their livelihood choices. This is important, given that cognitive factors like perceived abilities and options have been found to be important determinants of adaptive capacity (Grothmann and Patt, 2005; Kuruppu and Liverman, 2011).

We gained additional insight into agency by exploring which producers perceived "ability to negotiate" and "independence in market transactions" as benefits or challenges of participating in their current dairy market. We expected to find confirmation of concerns in the literature that modernized market producers have less power to negotiate and participate in decision-making. In interviews, producers selling in different modernized value chains described very similar day-to-day interactions. In these markets, producers are price-takers. The intermediary processor

collects milk from each farm, along with an individual sample for testing. Producers are then paid a price determined by the processor based on the quality (fat and protein profile) of their milk. Representatives of processing companies explained that the range of prices paid at a given time reflected market prices for dairy products. Producers could not negotiate different prices during this transaction, and many said they were frustrated with milk prices that had stagnated in recent years, despite rising costs of inputs. By contrast, farmers selling in traditional markets described how they regularly negotiated prices with their customers, often based on long-standing relationships. One very successful dairy producer and cheesemaker described how, despite producing sufficient volumes to sell to Dos Pinos, he preferred not to sell via the large processor because it allowed him to maintain his independence as a businessman.

However, while trends in survey responses followed our expectations, we found no significant difference in the proportion of modernized market farmers that perceived ability to negotiate and independence as market benefits or challenges (Figure 2.2). In the case of Dos Pinos, farmers described in interviews how, despite having little ability to negotiate on a day-to-day basis, they nevertheless had representation within the company as cooperative members, which gave them the capacity to influence company practices. As mentioned above, perceived ability to effect change is important to adaptive capacity.

Together, these results suggest that while participants in modern dairy value chains may have less agency and flexibility across some indicators compared to those selling in traditional markets, this is not true across all indicators.

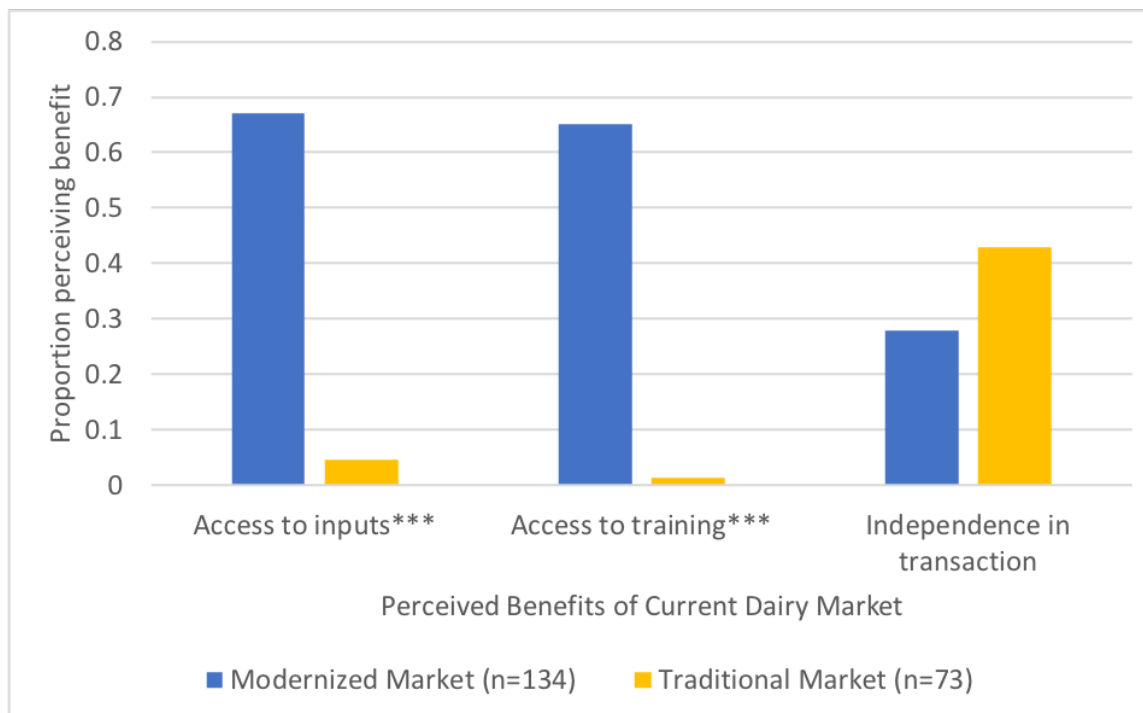


Figure 2.2 Perceived benefits of participating in current dairy market compared for modernized dairy market participants versus those in traditional markets. Significant differences indicated in axis label based on p-values adjusted using Benjamini-Hochberg correction (***) $p < 0.001$.

2.4.2 Modernized market farmers may have better adaptive capacity overall

Despite evidence that producers in modernized dairy markets may be more choice-constrained and have less agency than those selling in traditional markets, our data suggests that modern market producers in San Carlos may fare better across a broader suite of adaptive capacity indicators. As described above, participation in modernized dairy markets requires a high level of initial investment, meaning that many characteristics linked to adaptive capacity – like wealth and resources, access to credit, education, and input use – likely also facilitate participation in modernized markets. We found that modernized market farmers in San Carlos were significantly wealthier, had better access to resources, were more educated, and had higher rates of input and technology use compared to farmers in less modernized markets (Table 2.4, Figures 2.3 and 2.4).

While we were not able to establish causality (a common difficulty in market participation research – see Barrett et al., 2012) this suggests that at minimum, participation in modernized markets likely does not significantly decrease these components of adaptive capacity.

Table 2.4 Wealth indicators of farmers selling into modernized dairy markets compared to those selling in traditional markets.

	Test	Farmers who sell in modernized dairy markets (mean (t-test) or median (Wilcoxon) (N=134))	Farmers who sell in traditional dairy markets (mean (t-test) or median (Wilcoxon) (N=73))	95% Confidence Interval (difference of mean (t-test) or median (Wilcoxon))	Significance Based on p-values adjusted with Benjamini-Hochberg correction
Wealth Index	t-test	0.38	-0.71	(0.82, 1.3)	***
Price of milk (colones)	t-test	287.6	242.9	(32, 57)	***
Hectares owned	Wilcoxon	30.5	14	(3.0, 18)	**

* p<0.05 ** p<0.01 *** p<0.001

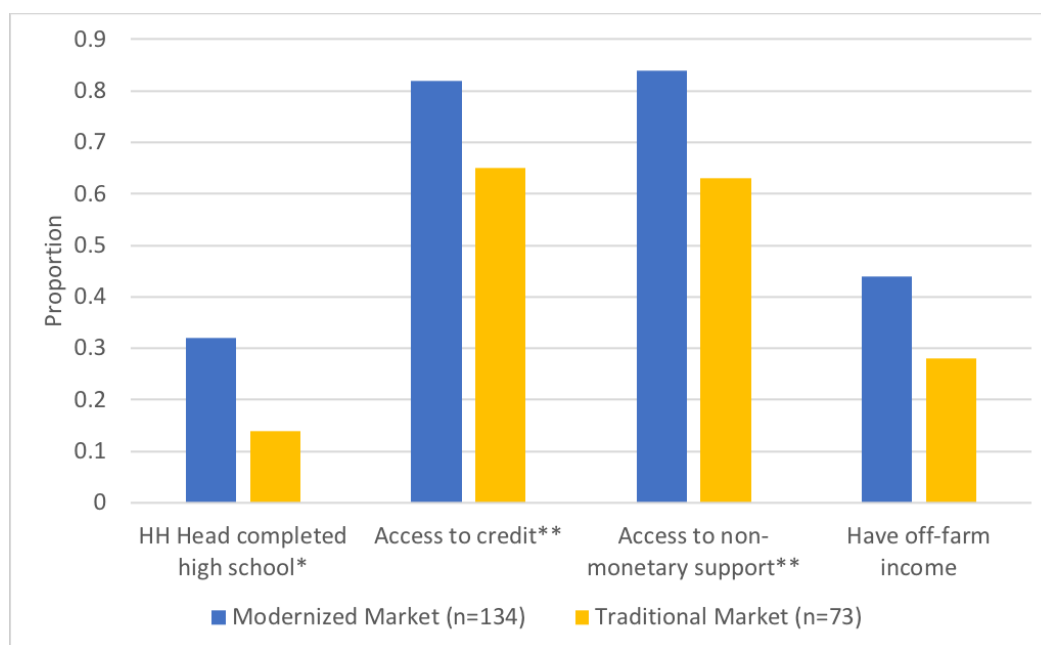


Figure 2.3 Comparison of education and access to resources by farmers selling in modernized versus traditional dairy markets. Significant differences indicated in axis label based on p-values adjusted using Benjamini-Hochberg correction (* $p < 0.05$, ** $p < 0.01$).

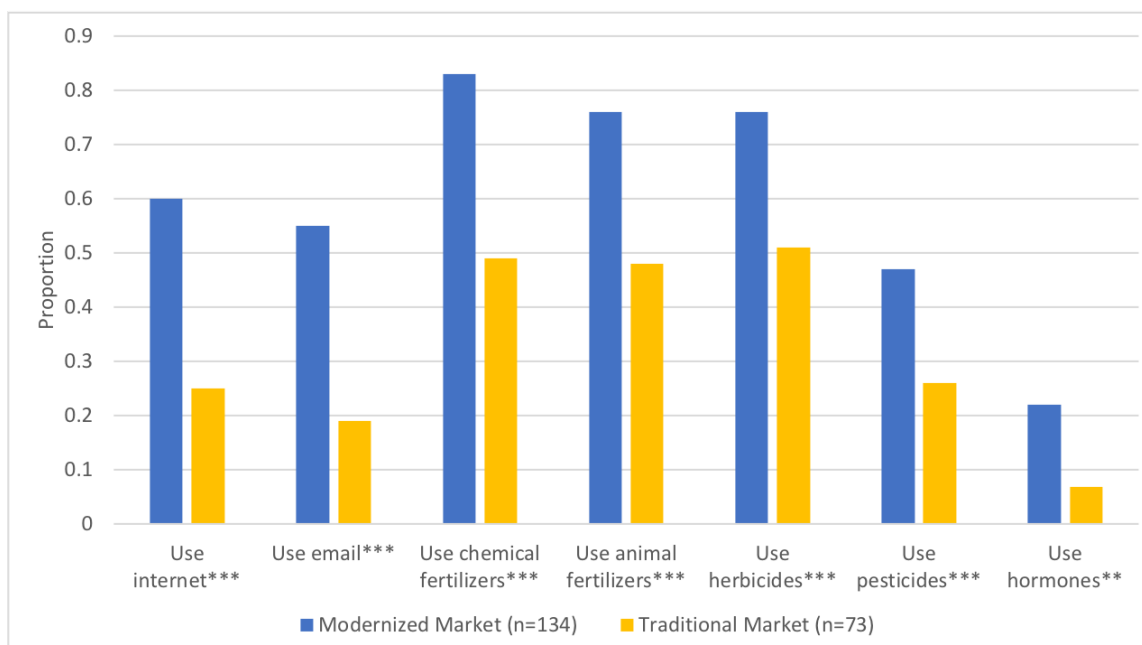


Figure 2.4 Indicators of technology use by modernized market participants versus traditional market participants. Significant differences indicated in axis label are based on p-values adjusted using Benjamini-Hochberg correction (** $p < 0.01$, *** $p < 0.001$).

A regression predicting modernized market participation similarly shows that a number of adaptive capacity indicators are significant predictors of participation (Table 2.5). Other studies have similarly found modernized market farmers to have greater wealth (Barrett et al., 2012; Briones, 2015; IFPRI, 2016) and input use (Barrett et al., 2001; Berdegue et al., 2005) compared to those in traditional value chains. In addition, we found that modernized market farmers likely had significantly higher cattle densities on their farms (although this effect size is not large), and were significantly more likely to consult agricultural information to inform farm management (Table 2.5). The relationship of education of the household head to modernized market participation was more complicated. Modernized market household heads were significantly less likely to have primary or secondary school as their highest level of education completed compared to the base case (informal education). The odds that a modernized market household head had completed post-secondary education were very high but insignificant (Table 2.5); given the very large confidence interval, we expect this result is due the low number of household heads who had completed post-secondary education overall. Taken together, these results suggest that household heads in modern market households had likely completed higher levels of education. While it does not demonstrate causality, this regression suggests that modernized market farmers were likely significantly better off across a number of adaptive capacity indicators compared to traditional market farmers.

Table 2.5 Results of logistic regression predicting participation in in modernized markets. Education was regressed as a categorical variable represented by dummies, with “Informal” education as the base case. After removal of cases with missing data, n=162.

Independent variable	Odds Ratio	Confidence Interval of Odds Ratio	Significance
Wealth Index	9.2	(4.1, 25)	***
Access to non-monetary support	4.6	(1.3, 17)	*
Density of cattle	1.4	(1.1, 1.9)	*
Consult agricultural information for farm management	16.5	(4.4, 7.8)	***
Use herbicides	4.6	(1.6, 15)	**
Use pesticides	3.9	(1.3, 13)	*
Education level completed by household head			
- Primary	0.21	(0.054, 0.73)	*
- High school	0.096	(0.014, 0.054)	*
- Post-secondary	65.3	(0.65, 26787)	
Cox Snell Pseudo R ²	0.49		
Model p-value	3.4 x 10 ⁻¹⁹		

* p<0.05 ** p<0.01 *** p<0.001

Regressions to examine how modern market participation is linked to adaptive capacity indicators while controlling for other factors showed modernized market participation to be a significant predictor of wealth index, chemical fertilizer use, and number of information sources consulted (Tables 2.6, 2.7, and 2.8).

We found modernized market participation to be a highly significant positive predictor of wealth index controlling for number of years farming land, sex of household head, farm efficiency (indicated by number of cattle per person working on the farm, including family members), and

highest education level completed by the household head (Table 2.6). Modernized market participation was also a highly significant predictor of number of information sources consulted to inform farm management, controlling for household organization participation (Table 2.7). Finally, modernized market participation was a significant predictor of chemical fertilizer use, controlling for wealth (Table 2.8).

Table 2.6 Results of linear regression of wealth index with modernized market participation. Regression controlled for years farming land, sex of household head, farm efficiency, and education of household head. After removal of cases with missing data, n=162.

Independent variable (market participation) and controls	Coefficient	95% Confidence Interval for Coefficient	Significance
Modernized market participation	0.91	(0.66, 1.1)	***
Years farming land	0.0074	(0.00054, 0.015)	*
Sex of household head	0.69	(0.15, 1.2)	*
Farm efficiency (cows per worker)	0.0068	(0.0013, 0.012)	*
Education level of household head			
- Primary	0.37	(0.095, 0.67)	**
- High school	0.66	(0.31, 1.0)	***
- Technical training	0.50	(-0.52, 1.5)	
- University	0.76	(0.29, 1.3)	**
- Post graduate	2.0	(1.0, 3.1)	***
Adjusted R ²	0.45		
Model p-value	2.2 x 10 ⁻¹⁶		

* p<0.05 ** p<0.01 *** p<0.001

Table 2.7 Results of logistic regression of number of information sources with modernized market participation. Regression controlled for organization participation (social capital). After cases with missing data removed, n = 163

Independent variable (market participation) and control	Odds Ratio	95% Confidence Interval of Odds Ratio	Significance
Modernized market participation	1.8	(1.3, 8.8)	***
Number of organizations household participates in	1.2	(1.1, 2.9)	*
Cox Snell Pseudo R ²	0.11		
Model p-value	1.1 x 10 ⁻⁴		

* p<0.05 ** p<0.01 *** p<0.001

Table 2.8 Results of logistic regression of chemical fertilizer use with modernized market participation, controlling for wealth. After removal of cases with missing data, n = 163.

Independent variable (market participation) and control	Odds Ratio	95% Confidence Interval of Odds Ratio	Significance
Modernized market participation	3.6	(1.5, 2.8)	**
Wealth	1.8	(1.1, 2.9)	**
Cox Snell Pseudo R ²	0.17		
Model p-value	2.9 x 10 ⁻⁷		

* p<0.05 ** p<0.01 *** p<0.001

While sampling did not allow us to establish causality, several pieces of evidence from our case study support the hypothesis that modernized market participation likely increases some indicators of adaptive capacity in this case. In the case of wealth and access to resources, farmers received significantly higher prices in modernized markets (Table 2.4). In addition, Dos Pinos,

and sometimes Sigma, offered their suppliers benefits like access to credit, information, and non-monetary support, like training and technical and veterinary services. A Dos Pinos producer explained that, despite spending more on inputs like fertilizer and pest control, the higher prices and benefits they received meant their margins were higher than if they were to sell in traditional markets. These factors could explain, at least in part, differences in wealth and access to resources between modernized and traditional value chain participants. In addition, our findings reflect other studies that have found modern market participation to increase income and improve access to inputs and information (Barrett et al., 2012; Bellemare, 2012; Otsuka et al., 2016).

We tentatively conclude that participation in modernized markets is likely increasing some aspects of adaptive capacity in San Carlos; at minimum, participation does not seem to greatly decrease adaptive capacity.

In particular, the case of small-scale Dos Pinos producers illustrates that Dos Pinos was considered the best market option by many producers. Producers frequently pointed out that only larger, wealthier producers can now afford to buy shares in Dos Pinos; however, when Dos Pinos started in the mid 20th century, farmers of all different sizes joined the cooperative by purchasing shares (with each share representing a volume of milk the producer was entitled to supply). As such, many smaller farms have effectively been “grandfathered in” to the cooperative. While it was explained that larger farms would not find sufficient market to sell all of their milk locally, and so effectively *had* to sell to a large processor, smaller Dos Pinos farmers did not face this constraint, and had the potential to recoup money tied up in shares by leaving the cooperative.

Yet, many small producers remained in Dos Pinos with no view to leaving and expressed satisfaction at the prices and benefits they received in the cooperative. This suggests that differences between modern value chains may be important.

Notably, our sample of modernized dairy market participants was dominated by farmers supplying Dos Pinos, largely because the formal dairy sector in San Carlos, and Costa Rica generally, is dominated by Dos Pinos. We did not sample a sufficiently large number of dairy farmers selling to private companies (i.e. Sigma) or via regional cooperatives (like Coopeleche or Coopebrisas) to detect statistically significant differences associated with selling to private companies versus Dos Pinos in modern value chains, or significant differences associated with selling via a cooperative more generally. However, response patterns to survey questions suggest similar trends for those supplying Dos Pinos and other modern value chains in most cases. In a number of cases, differences between modern and traditional value chain participants were exaggerated in the case of Dos Pinos farmers; in others, larger differences appeared to be associated with cooperative membership more generally. Further research would be useful to clarify outcomes associated with modern value chains with different characteristics.

2.5 Conclusions

We found that, while participating in modernized markets appears to restrict flexibility of market choice and to have some consequences for agency, several factors linked to adaptive capacity that likely facilitate modernized participation are at minimum not negatively affected by market participation. Together, these findings suggest that dairy farmers in San Carlos selling in modernized markets may have greater adaptive capacity overall – or at least, that they fare better

across several adaptive capacity components. This raises questions about the substitutability of different components of adaptive capacity, and the relative weight that should be assigned to each in understanding overall adaptive capacity.

Our findings suggest that participation in modernized markets may be both more accessible to those with greater adaptive capacity and also contribute to increasing adaptive capacity.

Modernized market participation might thus increase adaptive capacity at the individual farm scale for those who are able to participate, while simultaneously widening inequality overall at a regional or country scale. This study highlights the importance of considering outcomes at different scales. It also adds to concerns about inequity that have already been raised in the context of market participation, that less well-off producers may be excluded from modern value chains by private standards and by the geographic distribution of opportunities (Barrett et al., 2012; Kalfagianni, 2013; Schuster and Maertens, 2013). These findings are important, given that equity concerns are central to both adaptive capacity and sustainable development. Inequitable wealth and access to resources more generally are thought to negatively affect adaptive capacity (Eakin and Lemos, 2006; Park et al., 2012a), while successful adaptation to stresses like climate change is expected to require adaptation across multiple scales (Vermeulen et al., 2012). More broadly, equity is understood to be necessary for sustainable development (Biermann et al., 2012a).

While we observed the same trends for many adaptive capacity indicators across participants in different coordinated value chains, positive associations with several indicators were stronger for Dos Pinos producers. The literature demonstrates that cooperatives and producer organizations

have the potential to access and benefit from modernized markets by giving producers economies of scale, reducing risk, helping producers access information and technology, and improving their negotiating power (Bijman et al., 2012; Chagwiza et al., 2016; Ito et al., 2012; Shepherd, 2007; Wossen et al., 2017). However, to our knowledge, it is rare for developing country producer cooperatives to coordinate so many steps along a value chain and to be as dominant and powerful as Dos Pinos is in its sector, making Dos Pinos a rather unusual case. Other producers in our study were involved in smaller producer cooperatives (Coopeleche, selling into a modernized export value chain, and Coopebrisas involved in processing and selling regionally). While our samples from these cooperatives were too small to conclusively compare them to Dos Pinos, they do suggest that the trends we see with Dos Pinos producers are not simply an effect of cooperative membership. Further research to explore the Dos Pinos case would be fruitful to confirm observed trends and to determine whether they extend to other indicators of producer wellbeing beyond adaptive capacity. It would also be useful to understand what differentiates Dos Pinos from other coordinated value chains and cooperatives, and whether and how these differences translate into producer benefits.

Global food systems are changing, and with them, the commercial opportunities and rules of value chain engagement for farmers. In our study, an adaptive capacity lens suggests that, despite having some expected constraints on their farm management choices and ability to participate in decision making, farmers in modernized dairy markets in San Carlos appear better equipped to cope with change compared to those in traditional markets. Taking a broader view of wellbeing suggests that the important question is not *whether* there can be benefits to participating in more coordinated markets but rather, *how* can producers engage in these opportunities to improve their

livelihoods? This study emphasizes the importance of how producers interact with modernized value chains in determining wellbeing outcomes, and the intermediary buyer, as an important point of influence. Our research raises several questions: What terms of value chain engagement make it beneficial overall for a farmer to participate in a more coordinated value chain? How can government and NGO policy and programs be designed to shape value chains and support intermediary buyers to adopt practices and strategies that allow them to realize their goals while also securing benefits for producers? In this study's unusual case of a cooperative-intermediary in a modernized supply chain, we find evidence that this is one modernized value chain model that may support positive producer outcomes.

Chapter 3: Exploring producer participation in modernized value chains: the unusual case of a cooperative intermediary

3.1 Introduction

Agrifood value chains are becoming increasingly globalized and modernized, particularly supermarket and high-value export value chains. Two key characteristics of these “modern” value chains are vertical coordination and contract arrangements, and powerful, large-scale intermediary firms participating in – and controlling – multiple steps along the value chain between producers and consumers (Barrett et al., 2012; Busch and Bain, 2004; Gereffi et al., 2005; IFAD, 2016; Isakson, 2014; Okello and Swinton, 2007; Otsuka et al., 2016; Reardon et al., 2009; Reardon and Barrett, 2000; Reardon and Timmer, 2012; Wang et al., 2014). These characteristics have implications for producers who might want to participate in these new value chains.

An expanding literature exploring participation in modernized value chains and contract farming presents a complex picture of the benefits and challenges of participation for producers. On the one hand, there is evidence of participation benefits that include greater income and stability (Barrett et al., 2012; Minten et al., 2009; Otsuka et al., 2016; Ruben and Sáenz, 2008; Van der Meer, 2006). On the other, there may also be negative outcomes from participation, including decreased livelihood flexibility and negotiation power (González and Nigh, 2005; IFPRI, 2016; Isakson, 2014; Klasen et al., 2016; Reardon and Barrett, 2000; Shaver et al., 2015).

Despite the potentially mixed outcomes, there is interest from both researchers and practitioners in helping farmers – particularly smaller-scale farmers – to participate in modernized value chains to further rural development (Barrett et al., 2012; Donovan et al., 2015; Helmsing and Vellema, 2011; IFPRI, 2016; Shepherd, 2007; Slingerland et al., 2006; Taglioni and Winkler, 2014; Weatherspoon and Reardon, 2003). However, smaller scale farmers can face significant barriers to entering modernized value chains (Barrett et al., 2012; Henson and Humphrey, 2010; Van der Meer, 2006). There is evidence that producer organizations and cooperatives can help farmers to access and benefit from modernized markets by helping them to achieve necessary economies of scale, reduce risk, access information and technology, meet market standards, and by giving them negotiation power (Bijman et al., 2012; Chagwiza et al., 2016; Ito et al., 2012; Shepherd, 2007; Wossen et al., 2017). Cooperatives are particularly important in the dairy sector due to product perishability and high transaction costs (Bijman et al., 2012). However, although producer groups are widely considered to be important enablers of market access, they often cannot form without external support, and may not provide significant benefits in all contexts (Hellin et al., 2009). Partnerships between firms and non-value chain actors, like non-governmental organizations (NGOs) and governments, can also help to increase access to new market opportunities, provide information and resources, and facilitate relationships (Blanc and Kledal, 2012; Shepherd, 2007; Wossen et al., 2017). However, these interventions usually only reach a small subset of producers (Vorley et al., 2012), and their impact can vary considerably (Donovan and Poole, 2013). In short, the success of these interventions is by no means guaranteed (Shepherd, 2007).

As powerful, driving actors in modern food value chains, intermediary firms have considerable influence on the success of interventions to connect producers to these value chains. Elder (2016) describes one example in Nicaragua, where cooperatives and NGO intervention have not operated as hoped because of the actions of the value chain intermediary, Walmart. In this case, NGO-mediated buying agreements gave Walmart access to producer cooperatives, which Walmart used to identify and establish relationships with a few preferred suppliers, then excluding the rest of the cooperative from their supply chain. Despite the influence of intermediary firms on farmer benefits from modernized value chains, they have received relatively little attention in either value chain participation research (Reardon, 2015; Reardon and Timmer, 2012) or development-sector recommendations and guidelines (Donovan et al., 2015; Shepherd, 2007). In general, the food system literature lacks information on how modernization affects the structure and conduct of processing and distribution value chain segments (Reardon and Timmer, 2012). While some progress has been made in understanding how contracts used by intermediary firms are linked to farmer preferences and participation (Masakure and Henson, 2005; Ochieng et al., 2017; Schipmann and Qaim, 2011), there is still insufficient understanding of the interplay between contract terms, producer outcomes, and context factors (Ochieng et al., 2017; Otsuka et al., 2016). There is a growing understanding about how private standards created and enforced by intermediary firms are shaping food value chains and governance (Fuchs et al., 2011; Henson and Humphrey, 2010; Kalfagianni, 2013; Maertens et al., 2012; Schuster and Maertens, 2013); producer outcomes are explored to a lesser extent.

Value chain research has focused heavily on formal institutions and linkages, like standards and contracts, while informal institutions and organizational characteristics within value chains are

still poorly understood. Yet, these informal value chain attributes are likely important in shaping outcomes for both firms and producers. For example, factors like trust, reliability and reputation are understood to be important in contracting relationships (Barrett et al., 2012), and there is evidence that both suppliers and firms can benefit from close (Vorley et al., 2012) and long-term relationships (Gereffi and Luo, 2014). However, it is still poorly understood why contracting relationships fail, and more broadly, under what conditions the long-term participation of smaller-scale producers in modern value chains can be sustained (Barrett et al., 2012). As Gómez et al. (2011) point out, there is still a vast amount to learn about modern food systems, and how they can effectively contribute to sustainable development.

This paper addresses some of these gaps via a case study of dairy value chains sourcing milk from producers in San Carlos, Costa Rica. Using qualitative and quantitative data, we explore how firms in modern dairy value chains operating in San Carlos approach supplier relationships, and how these approaches correlate to producer wellbeing in these value chains. Contrasting the unusual case of Dos Pinos, a producer cooperative that has grown into a multinational processing and export firm, with other dairy value chains operating in the region, we develop hypotheses for how different approaches to supplier relationships may shape producer experiences and outcomes. We begin in Section 3.2, with an overview of the methods. In Section 3.3, we examine the Dos Pinos case. We provide evidence that suggests Dos Pinos suppliers experience multiple different types of benefits in their supply chain, in part because of how Dos Pinos, as a cooperative intermediary, approaches supplier relationships. Section 3.4 explores the idea that cooperative intermediaries might result in better producer outcomes more generally. First, we describe two spectra characterizing firm approaches to supplier engagement, contrasting Dos

Pinos with other modern value chains to illustrate. We present a hypothesis that firms that approach supplier relationships similarly to Dos Pinos might be better for producers. However, cooperative intermediaries may also have drawbacks; Section 3.4 goes on to discuss potential equality and sustainability issues highlighted by the Dos Pinos case. Finally, Section 3.5 presents conclusions and suggestions for future research.

3.2 Methods

3.2.1 Case study: Dairy farmers in San Carlos, Costa Rica

This study was conducted in the south of San Carlos, an important dairying area north of San José in Costa Rica. For a more detailed description of the study site and the dairy industry in Costa Rica generally, please see Chapters 1 and 2 of this dissertation.

Due to the geographic separation of modernized value chain collection routes and facilities (see study site description in dissertation Introduction), producers in San Carlos who preferred to sell into modernized value chains were effectively in a monopsony situation, where they only had one modernized value chain option in their area. For larger producers, a modernized value chain was the only viable option, as producers explained it was generally not possible to sell large volumes of milk locally.

3.2.2 Sampling, data collection and analysis

For this study, we collected and analyzed qualitative and quantitative data in a case study of the Costa Rican dairy sector, focusing on the dairying region of San Carlos north of San José. Qualitative data was collected via meetings with dairy sector key informants and formal semi-

structured interviews with 16 key informants, including producers identified as “community leaders” and representing a diversity of farming and marketing experiences, firm and cooperative representatives from modern dairy value chains, and a government agricultural extension worker based in San Carlos. Interview questions asked participants about the structure and functioning of dairy value chains, producer experiences in and with different value chains (including exclusion from value chains), and about how producers and firms made decisions about entering and leaving firm-supplier relationships. Producers were asked to speak both about their own experiences, as well as what they knew, as community leaders, about the experiences of their colleagues.

We collected quantitative data in a survey of 207 dairy farmers in San Carlos (Table 3.1). Survey questions asked about household demographics, characteristics of dairy markets, producer experiences in these value chains, and a broad range of wellbeing indicators – including a standardized psychometric Satisfaction With Life Scale (Diener et al., 1985) and questions about household and farm assets which were used to construct an asset-based Wealth Index (Filmer and Pritchett, 2001; Rutstein and Johnson, 2004) .

For a more detailed description of wellbeing variables, Wealth Index construction, sampling and data collection, please see Chapter 1 of this dissertation.

Table 3.1 Dairy market and producer cooperative characteristics of survey participants. In total, 134 survey participants were selling into modern value chains, and 73 were selling into traditional value chains. Regional cooperatives included Coopeleche, which was selling exclusively to Costa Rican multinational beverage company Florida Bebidas (and modern value chain), and Coopebrisas, which owns a processing plant and sells exclusively in the region. Regional and local buyers included consumers, small local processing plants, retailers, and wholesalers in traditional value chains.

	Cooperative Multinational (Dos Pinos)	Private Multinational (Sigma)	Regional Cooperative	Non- Cooperative Regional and Local Buyers
Modern Value Chain	111	18	5	-
Traditional Value Chain	-	-	6	67

We used qualitative analysis to understand the functioning of dairy value chains, how different actors understand supply relationships and how they make decisions about whether to participate in these relationships, and the barriers that exclude some producers from certain supply chains.

We used qualitative methods to summarize and inductively identify themes and ideas in the interviews, and link these to our research objectives (Thomas, 2016). We used this analysis, along with notes from informal meetings with more than 20 key informants and insights into the Costa Rican context provided by media and dairy sector reports to develop hypotheses about differences in firm-supplier relationships and how these differences might translate into differences in experiences for producers. We also used qualitative analysis to cross-check patterns and trends observed in the survey data, and to add nuance and depth to our understanding of the survey analysis.

To explore how wellbeing differed for producers selling via Dos Pinos versus producers in all other modern value chains, we compared these two producer groups using R statistical analysis

software. We used t-tests to compare means for continuous variables, substituting Wilcoxon tests for non-normally distributed variables. We used proportion tests to compare binary variables, substituting Fisher tests where any variable had a cell count less than ten. We report significance based on p-values adjusted using the Benjamini Hochberg method to control the False Discovery Rate across multiple tests (Benjamini and Hochberg, 2000; 1995; Krzywinski and Altman, 2014). The value chain including the Coopebrisas producer cooperative has characteristics of both modern and traditional value chains; for the purposes of this analysis, Coopebrisas suppliers were included with traditional value chain suppliers (see Chapter 1 of this dissertation).

Because our sample of farmers selling to private firms in modern value chains was too small to detect statistically significant differences, we compared Dos Pinos to private firm modern value chains alone by comparing means and medians to suggest preliminary (rather than conclusive) trends. Similarly, our sample of participants in regional cooperatives was too small to detect statistically significant differences between Dos Pinos and regional cooperatives. To gain insight into whether observed trends are likely explained by cooperative membership generally rather than Dos Pinos specifically, we looked for tentative trends in wellbeing indicators comparing Dos Pinos producers to those in Coopeleche and Coopebrisas.

3.3 Dos Pinos: A good gig

On the surface, modern dairy value chains in San Carlos appear to have many important similarities. Producers selling to Dos Pinos, Sigma Alimentos and Coopeleche all describe similar daily interactions with their milk buyers, including almost identical procedures for milk collection and testing, parameters and procedures for determining milk price, and procedures for

dealing with sub-quality supply. Representatives from Dos Pinos and Coopeleche describe very similar cooperative agreements and priorities with respect to their members. Sigma, Dos Pinos and Coopeleche say they provide similar types of supports to producers. And yet, as the following section suggests, there may be important differences in producer wellbeing between dairy producers in San Carlos selling via Dos Pinos compared to those selling in other dairy value chains.

3.3.1 A voice in shaping the value chain

Autonomy is understood to contribute to wellbeing (Deci and Ryan, 2000; Ryan and Deci, 2006; 2000). Ability to participate in value chain management and negotiation are relevant to autonomy with respect to value chain participation. Participation in value chain management is a key component of legitimacy in modern value chains (Fuchs et al., 2009). At the same time , there is concern that participation in modern value chains may reduce the ability of producers to negotiate the terms of their market engagement (González and Nigh, 2005; IFPRI, 2016; Reardon and Barrett, 2000). Thus, the ability of producers to participate in shaping how their value chain operates and the terms on which they engage is arguably an important wellbeing indicator with respect to participation in modern markets. As both a producer cooperative and a multinational company, Dos Pinos is well-positioned to provide its producers with opportunities to shape a modern value chain. While Dos Pinos producers can't negotiate in their daily interactions any more than other modern value chain producers, Dos Pinos producers have a voice within the company via elected representatives who participate in decision-making within Dos Pinos.

Most of the examples of producer cooperatives that have been studied in developing countries operate at a level one step above the producer in the value chain – like the Coopeleche cooperative in San Carlos, which manages milk supply and collection from its members on behalf of its sole buyer, Costa Rican multinational Florida Bebidas. Instead of engaging with individual producers, the intermediary firm engages with the cooperative. The cooperative and processing firm are separate entities, meaning producers have less power to influence the practices of the firm, and the exchange of milk and money between cooperative and firm is a separate step in the value chain. In some cases, a cooperative will engage in activities at additional levels of the value chain, usually processing; for example, coffee cooperatives may purchase equipment to wash and sort coffee berries prior to sale (Elder, 2010). Occasionally, a cooperative controls a significant portion of a value chain, as in Costa Rica, where Coopebrises runs a dairy processing plant that makes, markets and distributes dairy products in the local area. Although more common in the European dairy sector (Bijman et al., 2012), producer cooperatives that control modern, multinational value chains are rare in developing countries.

Vertical integration in modern value chains often involves the middle of the chain: processing, distribution, marketing, retail. An intermediary company internalizes or controls multiple steps in the value chain, often with consumption and production at either end of the chain being the only steps left unintegrated. While this coordination has benefits for efficiency and competitiveness, it can give the intermediary significant control over the value chain, and over producers (Fuchs et al., 2011; 2009). Intermediary firms can create further vertical integration via contract arrangements with producers (Okello and Swinton, 2007). Producers tend to have little

negotiating power in contractual arrangements with powerful intermediary firms and little recourse if firms renege (Barrett et al., 2012).

Like controlling firms in other modern dairy value chains, Dos Pinos vertically integrates its value chain from distribution and export down to producers, but with the important distinction that producers are members – and voting owners – of the company. Unlike producers supplying most modern value chains who are linked by contracts over which they have little control, Dos Pinos' producer-owners have the potential to participate in shaping their modern value chain via representation and democratic processes. They may also benefit from the efficiency and competitiveness gains of being part of a more coordinated value chain. While separate producer cooperatives like Coopeleche are thought to offer producers more bargaining power relative to engaging with powerful firms independently (Barrett et al., 2012), producer cooperatives still have only limited ability to influence the controlling actor in their value chain. In Dos Pinos, although a separate group of employees and shareholders (rather than producer members) is responsible for non-agricultural operations (processing, marketing, distribution, export), producers are company co-owners, and can become employees, putting them on a potentially more equal footing with the controlling firm than most other producers in modern value chains.

A Dos Pinos member explained how producers participate in company decision-making via democratic representation:

“The entity that decides everything in Dos Pinos is the General Assembly of Delegates. We have associates that represent groups of producers. Each producer represents four

more producers besides himself. This is decided in regional elections, in which it is decided which delegates will make the big decisions representing their associate [producers].”

The process gives producers hope that they can effect change when they have concerns. For example, two producers in the same family first articulated concerns connected to the growth of the non-producer side of Dos Pinos, but then went on to express hope for their future with the cooperative because “it is possible to negotiate in the cooperative and propose necessary changes via our representatives”.

3.3.2 Benefits and challenges for producers

A Dos Pinos employee explained how the position of producers as co-owners links the wellbeing of the company to the wellbeing of its suppliers. This translates into a number of ways in which Dos Pinos looks after its supplier-owners. Producers described many of the benefits they receive from Dos Pinos, including access to low-cost inputs (compared to market rates), credit, training, farm management and technological information and training, and veterinary and technical services. Dos Pinos also paid its producers high prices – the highest in Costa Rica (Madriz Carillo, 2014). The share system used by Dos Pinos and other cooperatives provided producers with a stable (weekly) and predictable income based on their supply quota (based on the number of shares owned) and Dos Pinos’ prices. Finally, Dos Pinos purchased all the milk a farm produced, including volumes above a farm’s quota (at a reduced price). While this practice stemmed from a requirement in Dos Pinos’ cooperative agreement that does not allow producers to sell milk to any buyer but Dos Pinos, Dos Pinos members almost universally spoke about the practice in a positive light. Dos Pinos producers had a guaranteed buyer for their entire

production, and thus lower risk in the face of fluctuating milk supply and demand compared to non-Dos Pinos producers. Producers and a government extension officer gave examples of how other dairy value chains in San Carlos, including Sigma, other cooperatives, and many traditional value chains, did not provide the same level of security or producer supports.

Dos Pinos farmers perceived many benefits from selling into their dairy market (Figure 3.1). Producers selling via Dos Pinos were significantly more likely than others selling into modernized markets to perceive benefits related to the price they received for their milk, and they were less likely to perceive challenges related to milk price (Figure 3.2). Dos Pinos farmers were also significantly more likely to perceive benefits related to access to inputs and training opportunities compared to other modernized value chain farmers. Dos Pinos farmers were less likely to perceive challenges related to accessing inputs and transport, and more likely to perceive no significant challenges related to their dairy market (Figure 3.2). These findings suggest advantages of selling to via Dos Pinos over other modernized value chains in San Carlos.

Our sample sizes of producers in regional cooperatives (Coopeleche and Coopebrisas) were too small to compare Dos Pinos to these cooperatives statistically. However, a visual comparison of the benefits and challenges perceived by regional cooperative members compared to those selling in private modernized value chains and traditional value chains (Figures 3.1 and 3.2) suggests that some of the differences between producers in Dos Pinos versus other value chains might be due to cooperative membership. Given the small size of our sample of non-Dos Pinos modernized and regional cooperative value chain farmers, further research would be necessary to confirm these findings.

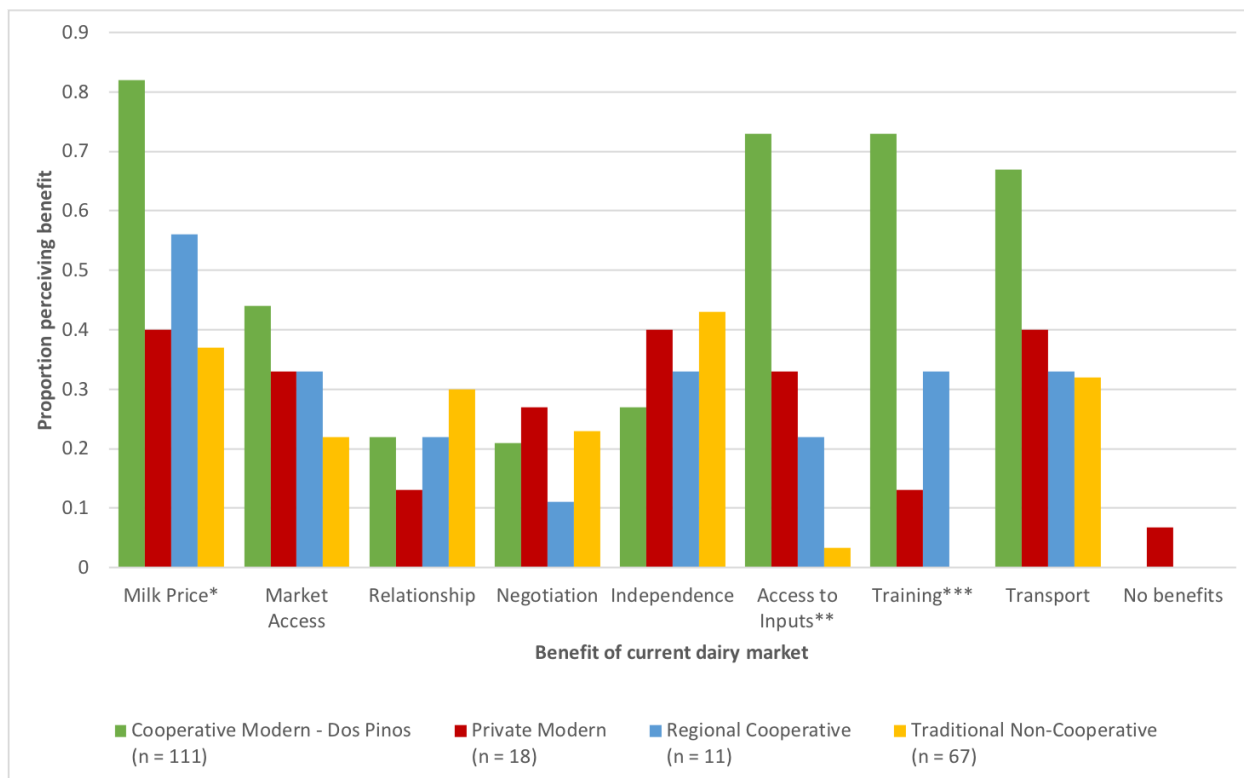


Figure 3.1 Perceived benefits of selling into different dairy value chains in San Carlos. Regional cooperatives selling into modern and traditional value chains have been combined for this graphic to allow visual comparison of Dos Pinos producers to producers in regional cooperatives. Significant differences between Dos Pinos and other modern value chain farmers are indicated in x-axis labels based on p-values adjusted using Benjamin-Hochberg correction (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$).

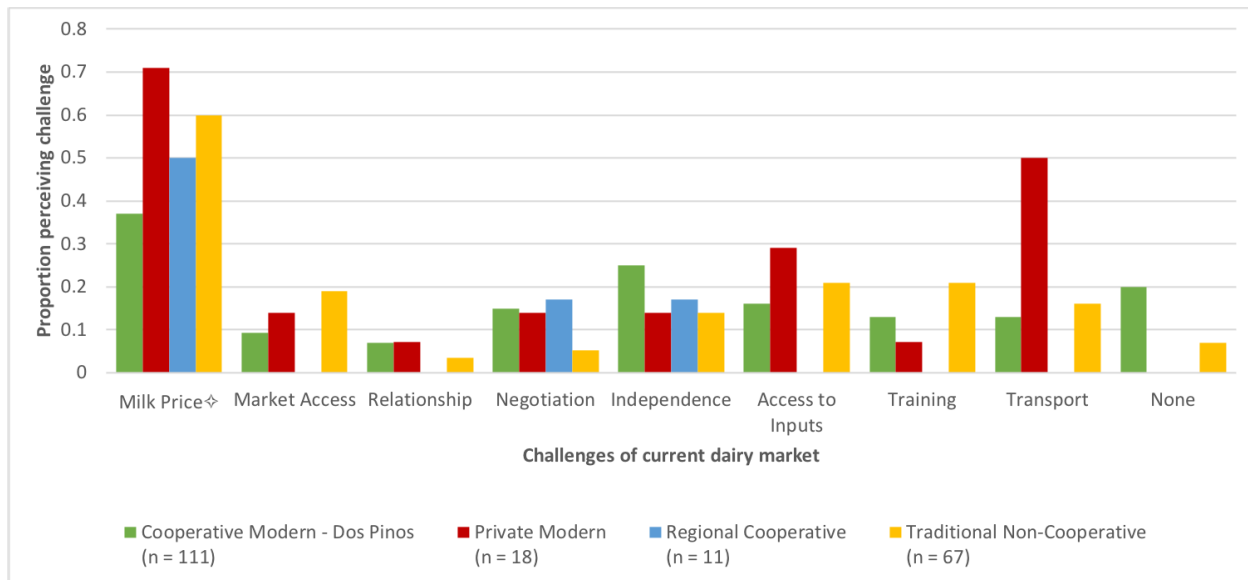


Figure 3.2 Perceived challenges when selling into different dairy value chains in San Carlos. Regional cooperatives selling into modern and traditional value chains have been combined for this graphic to allow visual comparison of Dos Pinos producers to producers in regional cooperatives. ($^{\diamond}$ $p < 0.1$ after Benjamini-Hochberg correction).

3.3.3 Benefits and challenges for producers

Dairy farmers in San Carlos selling into modernized, vertically coordinated markets are likely better off compared to farmers selling locally across several indicators of adaptive capacity, including some like wealth that are also linked to present wellbeing (see Chapter 1 of this dissertation for an overview of wellbeing and adaptive capacity indicators, and Chapter 2 for an overview of adaptive capacity). Our sample numbers of those selling to private buyers in modern value chains and those selling via local level producer cooperatives are too small to detect significant differences in most cases. However, some compelling trends are apparent in multiple wellbeing indicators when Dos Pinos farmers are compared to those selling in other value chains (Table 3.2). For some indicators, like wealth (indicated by asset ownership), milk price, and cattle per farm worker (an indicator of farm efficiency), general trends apparent in modernized

value chain farmers appear stronger for Dos Pinos farmers. Finally, for some indicators, like hectares owned, non-Dos Pinos modern value chain farmers appear to more closely resemble those selling in traditional value chains. We found significant differences between Dos Pinos farmers and those selling into other modernized markets for several indicators, including head of cattle owned, milk price, and several indicators of adaptive capacity, including number of products produced on the farm (indicating farm diversity), and years cattle farming, years farming current land, and years selling in current dairy market (indicating experience and stability).

Table 3.2 Comparison of median characteristics of farmers selling into different dairy markets in San Carlos.

Variable	Dos Pinos (n = 111)	Private modernized (n = 18)	Regional cooperative (n = 11)	Traditional (n = 67)
Median wealth index [◇]	0.50	0.29	0.09	-0.64
Median hectares owned	34	15.5	12	15
Median cattle owned*	83	50	40	30
Mean milk price (colones)*	292	267	265	242
Median cattle per farm worker*	31	25	20	20
Median years selling in current dairy market***	24	5	8.5	6
Median years farming land*	28	12.5	20	20
Median years as cattle farmer*	29	17.5	20	20
Median number of farm products*	2	1	1	1

[◇] p<0.1 * p<0.05 ** p<0.01 *** p<0.001

Significance, after Benjamini-Hochberg correction, of t-tests and Wilcoxon tests comparing Dos Pinos farmers to others selling into modernized dairy markets.

Causality is unclear, and several indicators may facilitate access to modern value chains and also be enhanced by that access. For example, those who have been cattle farmers longer may have been able to join Dos Pinos back when the cooperative started in the mid 20th century when shares were less expensive and more readily available. Participation may also enable continued farming (thus explaining years selling in current dairy market, farming land, and as a cattle farmer). Similarly, having greater wealth could allow investments in shares and equipment that would facilitate access to modernized value chains like Dos Pinos or Sigma; wealth could also

increase via higher milk prices. In the case of Dos Pinos, milk prices were significantly higher than those reported in other modern markets, which are in turn higher than those reported by farmers in traditional markets. The focus of Dos Pinos on increasing efficiency in its member producers reported by both a representative of Dos Pinos' producer support and education division and several Dos Pinos farmers, together with our finding that Dos Pinos farmers are significantly more efficient on at least one efficiency measure, suggests that Dos Pinos farmers may be accruing greater wealth, on average, than other dairy farmers. Generally, it appears likely that Dos Pinos farmers are better off than other dairy farmers in San Carlos, at least in part, because of their involvement in Dos Pinos.

3.3.4 Loyalty and relationship longevity

Producers can benefit from long-term relationships with firms (Vorley et al., 2012). This suggests that Dos Pinos farmers likely benefit from the fact that they had spent significantly longer selling into their current dairy market (Table 3.2). This finding is likely due in part to how long various market opportunities have been available. The Dos Pinos cooperative formed in 1947. By contrast, key informants reported that Sigma began operating in Costa Rica less than 15 years prior to this study, while Florida Bebidas only entered the dairy sector in 2012 (although the Coopeleche cooperative formed earlier in 1976) (Barquero, 2012). However, the survey finding that a greater proportion of Dos Pinos farmers perceive no significant challenges to their dairy market (Figure 3.2), coupled with survey responses about dairy market changes and qualitative data, suggests that number of years in current dairy market may also reflect varying producer satisfaction with different value chain opportunities.

There is evidence that producers benefit from close relationships with buyers (Gereffi and Luo, 2014), and will exercise their agency and leave value chains when they perceive trust and fairness to be lacking in their relationships with suppliers, or if they perceive a better opportunity elsewhere (Elder and Dauvergne, 2014). This suggests that movement between value chains, and motivations for this movement, can shed light on the quality of relationships producers have with buyers in different value chains, and consequently, the potential for wellbeing benefits from these relationships.

Twenty-two producers reported changing dairy value chains in the five years prior to our survey. Of these, four had left Dos Pinos while seven had left Sigma, despite Dos Pinos having a much higher market share in San Carlos. Three of the four producers who left Dos Pinos did not cite a problem with Dos Pinos, but rather cited selling their shares as their reason for leaving, suggesting their primary motivation may have been a desire to recoup their investment. In contrast, producers who left Sigma cited issues with transportation, milk prices, and stability. A government agricultural extension agent in San Carlos explained that in his experience, Sigma paid poorly and “changed the rules and left [producers] hanging”. Producers shared multiple stories about dairy buyers who had reneged on agreements or payments, or who were suspected of deceiving producers. Buyers identified in these stories included Sigma, cooperatives and processors other than Dos Pinos, and cheese merchants.

By contrast, Dos Pinos was repeatedly described in both interviews and surveys as a very reliable buyer, even by a Dos Pinos member who was frustrated and contemplating leaving the cooperative: “One always has complete confidence in Dos Pinos. They have never wronged

someone in a payment.” In an open question about what producers consider when choosing a dairy market, 17% of Dos Pinos members responded saying that tradition or legacy was their only consideration, suggesting a strong loyalty to their buyer. Tradition or legacy was not cited by producers selling in other markets.

Further research would be needed to more definitively understand the reasons and characteristics of dairy farmers changing value chains in San Carlos. However, together, our findings suggest that Dos Pinos producers may experience better relationships with their buyer compared to other value chains – particularly the largest modern value chain alternative, Sigma Alimentos. Where better relationships contribute to relationship longevity, we hypothesize both producers and firms could benefit from stability and avoiding expenditures of time and resources seeking out new buyer/supplier relationships.

3.3.5 Satisfaction With Life Scale

Dos Pinos farmers may also be more satisfied with their lives, as indicated by responses to a five question psychometric Satisfaction With Life Scale (SWLS) (Figure 3.3), understood by wellbeing scholars to be a component of self-reported wellbeing (Diener et al., 1985; Pavot and Diener, 2008) (see Appendix A for more details). Dos Pinos farmers were significantly more likely to “Agree” or “Completely Agree” with the statement “The conditions of my life are excellent” compared to farmers in other modernized markets. Across all five statements in the SWLS, plus an averaged response (sum of Likert scale responses to the five statements, divided by five), Dos Pinos farmers appear to be more satisfied than farmers in modernized markets with

a private intermediary, and somewhat more satisfied than those selling in traditional value chains.

Although our sample size of regional cooperative producers is too small to compare groups statistically, Figure 3.3 suggests that cooperative membership may explain trends in the responses of Dos Pinos farmers. In addition, though not significant, cooperative members also appear more likely to agree with the statement “My farm is successful”. Given that perceived success and competence are also understood as constituents or components of wellbeing (Deci and Ryan, 2000; Diener et al., 2009), this trend could signify another wellbeing indicator on which Dos Pinos members are better off compared to many other dairy producers in San Carlos.

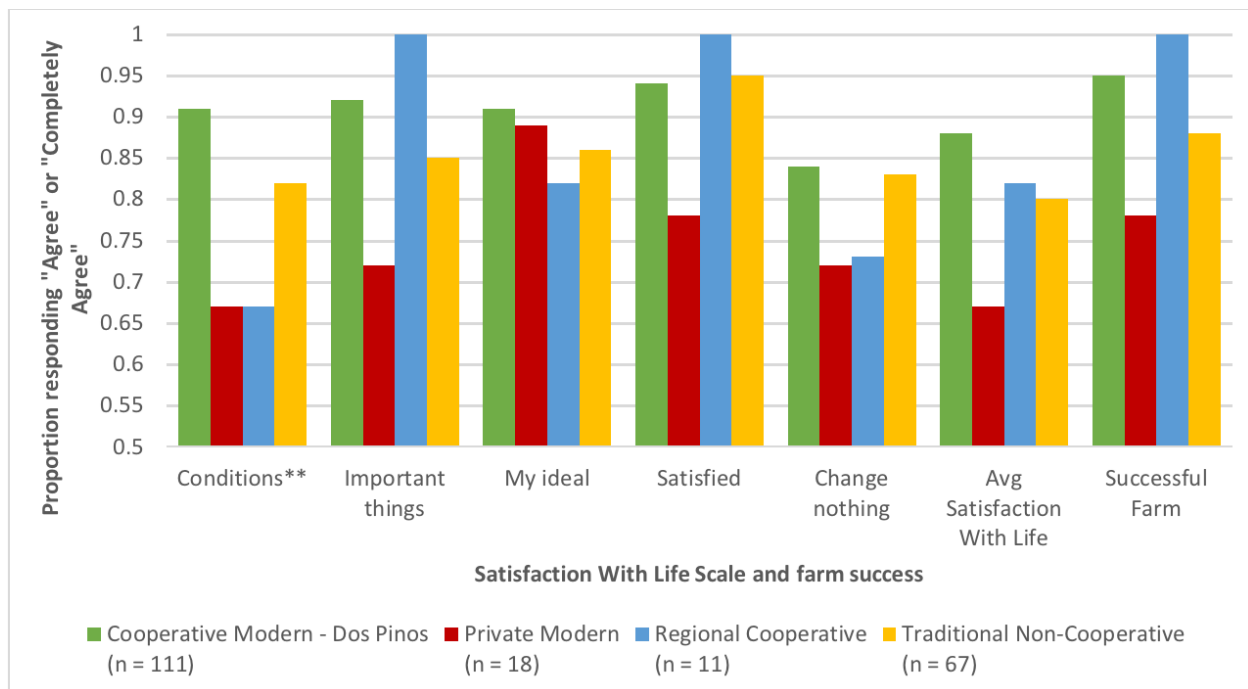


Figure 3.3 Proportion of participants in different dairy markets responding “Agree” or “Completely Agree” to Satisfaction with Life Scale (SWLS) questions and to the statement “My farm is successful”. For the SWLS, respondents answered on a 5-point Likert scale to the following five statements (Appendix A): The conditions of my life are excellent (“Conditions”); So far I have gotten the important things I want in life (“Important Things”); In most ways my life is close to my ideal (“My Ideal”); I am satisfied with my life (“Satisfied”); If I could live my life over, I would change almost nothing (“Change nothing”). “Avg Satisfaction with Life” is the summed SWLS score divided by 5. A significant difference (** $p < 0.01$ after Benjamini Hochberg adjustment) was found between Dos Pinos farmers and farmers in other modernized value chains in responses to the statement “The conditions of my life are excellent”.

While not conclusive, our data suggest that different modernized value chains may provide different opportunities and benefits to participating producers. Previous studies have found wellbeing benefits associated with modern value chain participation and with cooperative membership. Our study suggests that Dos Pinos producers may be better off compared to both producers in regional cooperatives and those in other modernized value chains in San Carlos. This gives weight to the “cooperative intermediary firm” as a compelling model for securing producer benefits in modernized value chains. Given that market participation research has

focused primarily on differences between those selling into modern versus traditional value chains, we suggest that more research would be prudent to understand how differences between modernized value chains are linked to different outcomes for participating producers.

3.4 Cooperative intermediaries: A good gig in general?

The preceding section raises the question as to whether a “cooperative intermediary” like Dos Pinos might be expected to benefit producers in modern value chains more generally. In this section, as a first step to answering this question, we first suggest a characterization of firm approaches to supplier relationships and apply it to San Carlos value chain intermediaries to explore why a cooperative intermediary may be expected to benefit producers. We then use the Dos Pinos case to illustrate two potential challenges we see with cooperative intermediaries.

3.4.1 Seek or Create, Maximize or Relate: Characterizing approaches to producer engagement

Intermediary firms in modernized markets aim to maximize profits while competing in terms of both quality and cost (Reardon and Timmer, 2012). Dairy processing and distribution companies like Dos Pinos and Sigma need a consistent supply of milk that meets their quality requirements, at a cost that allows them to remain competitive in their markets. However, these end goals need not be met in the same ways. Dairy sector key informant interviews highlight differences in how Dos Pinos and Sigma describe their suppliers, which we use to illustrate two complimentary spectra characterizing firm approaches to supply and producer engagement.

The first spectrum describes a company's approach to filling their supply needs, with "Seek" at one end of the spectrum, and "Create" at the other. Firms characterized by a "Seek" approach spend resources identifying and securing supply relationships with producers who can meet their quality and quantity requirements at the lowest cost. Firms characterized by a "Create" approach invest in existing suppliers to help them become more efficient, cost effective suppliers. As a cooperative with indefinite-term supply agreements with its producer-members, Dos Pinos necessarily takes a "Create" approach. Dos Pinos was not seeking new suppliers, but rather, invested time and resources into education and supports aimed at increasing the production, efficiency, and milk quality of their current members to meet their supply needs.

By contrast, Sigma Alimentos sits somewhere in the middle between "Seek" and "Create" approaches. Unlike Dos Pinos' cooperative agreements, Sigma's contracts, which lasted an average of one month, prioritized flexibility to allow the company to use a more cost effective supplier if one became available. Eighty percent of these contracts were verbal, giving added flexibility. A representative of Sigma explained that this flexibility gave producers the ability to withdraw from the arrangement if they found a better price elsewhere, but also gave Sigma the ability to withdraw if they were unhappy with the milk quality. Sigma's approach wasn't entirely "Seek", however, as Sigma recognized that in the face of increasing competition and globalization, "it is necessary to develop producers to ensure a sufficient supply of milk always exists." To this end, Sigma offered some training programs and support, like credit, to its suppliers.

An example of a “Seek” approach can be seen in the fresh vegetable value chain involving Walmart in Nicaragua (Elder, 2016). To supply its supermarkets, Walmart sources some of its fresh fruit and vegetables from small scale farmers, sometimes via cooperatives. In Elder’s study (2016), cooperatives were seen by Walmart to be a “business tool” that allowed the company to meet supply requirements cheaply, and gave it access to preferred suppliers. Walmart bought from less than 20% of cooperative members, provided no producer supports, and used contracts that lasted a single growing season to maintain their flexibility.

A second complimentary spectrum to characterize firm approaches to supply relationships - “Maximize” versus “Relate” - describes the focus of firms in supply relationships. Firms with a “Maximize” approach prioritize short term efficiency in their supply relationships; producers are treated as one component in a process that aims to maximize returns. At the other end of the spectrum, firms with a “Relate” approach prioritize the relationships they have with producers, as these relationships are understood to be the mechanism by which the company secures loyalty, and thus a consistent supply of quality product.

Sigma tends towards a “Maximize” approach. When asked to describe a preferred supplier, a representative of Sigma focused on farm assets and characteristics, explaining that they prefer larger scale producers because they are more efficient. Another indication that Sigma prioritizes maximizing returns over supplier relationships: 50% of their milk collectors are subcontractors, meaning that Sigma employees are less involved in the company’s day-to-day interactions with suppliers, and Sigma has less control over how these interactions unfold. We expect this

distancing of Sigma from its suppliers could be important given that a personal relationship with buyers can drive producer market choice (Schipmann and Qaim, 2011).

By contrast, Dos Pinos takes more of a “Relate” approach. It has long-term supply relationships with a relatively consistent, specific, group of farmers. A Dos Pinos employee described their suppliers as “co-owners” who must be cared for:

“The dairy value chain starts at the farm. All the producers are associates [of the cooperative] and are thus co-owners of the company. The [Dos Pinos Education] committee must meet the needs of the associates so that they as producers are efficient and have higher production and therefore can increase their margins.”

The wellbeing of the firm is understood to be directly connected to the wellbeing of its suppliers. When asked about the characteristics they preferred in suppliers, a representative of Dos Pinos focused on character attributes of the farmers themselves, identifying “being prepared to work under suboptimal conditions” and understanding “the proper use of farm resources to lower costs” as desirable supplier characteristics. The Dos Pinos representative then went on to explain that the “level of production is not linked directly to a strategy of efficiency or profits. It is more a matter of methodology, of persistence, of education, of control so that production is efficient.” In short, Dos Pinos seeks to realize its goals not via a simple profit maximization equation, but rather, by working with producers to improve their production processes.

We hypothesize that producers participating in modernized value chains where firms take “Create” and “Relate” approaches to meeting their supply needs will tend to experience greater

benefits from participation compared to those participating in value chains where firms tend towards “Seek” and “Maximize” approaches. Farmers have the potential to benefit from the firm investment in farmers that “Create” and “Relate” approaches imply (which has been associated with higher incomes (Schöll et al., 2016)), and because of the relative stability that is possible in longer-term market relationships. We hypothesize that where firms are invested in supplier relationships, they may be more likely to seek and incorporate producer priorities into the terms of supply relationships, thus giving farmers greater agency.

We hypothesize that firms can benefit from a range of different approaches across the spectra, with resources being distributed differently in each case. We expect that a “Seek/Maximize” approach to securing suppliers results in higher turn-over of suppliers. Firms likely spend more resources finding new suppliers, but they may be more likely to consistently have a group of suppliers who can meet firm needs at the lowest cost at any given time. By contrast, a “Create/Relate” approach would require a firm to spend more time and resources investing in relationships and farmer development and could restrict firm freedom in choosing suppliers. However, by building supplier loyalty, the firm would presumably spend less resources seeking out new suppliers. Indeed, a “Create/Relate” approach could be preferable in some sectors where investment in the wellbeing of potential suppliers may be necessary to secure the long-term sustainability of supply (Gereffi and Luo, 2014).

Producer cooperatives, including local cooperatives, likely support “Create” and “Relate” approaches, largely by virtue of the fact that they have indeterminate supply relationships with their producer members. However, Walmart’s relationship with local level producer

cooperatives, described above, contrasts sharply with the relationship Coopeleche described with its multinational buyer, Florida Bebidas in Costa Rica. Florida's supply agreement is with Coopeleche, not with individual producers, and is understood to be ongoing. Coopeleche managed supply on behalf of Florida in a similar way to Dos Pinos, in that it invested in its member owners to secure sufficient high-quality supply. The contrast between Walmart and Florida's relationships with cooperatives suggests that including a local level producer cooperative in a modern food value chain is not enough in itself to secure beneficial producer outcomes; the approach of intermediary firms to relationships with cooperatives is also important. In the case of Dos Pinos, the cooperative intermediary, producer-firm relationships are internalized, and producer interests and firm interests are more intertwined. As such, cooperative intermediaries may be particularly beneficial arrangements for producers.

3.4.2 A good gig - if you can get it

A first caveat to the potential benefits of a cooperative intermediary for producers focuses on the potentially exclusive nature of cooperatives. Dos Pinos' approach to supplier relationships appeared to work well for many of the producers lucky enough to be members, and therefore recipients of the cooperative's investment. However, the very attribute that secures many benefits for Dos Pinos' suppliers – it being a cooperative – also excludes those who are not members. It was widely agreed by producers and dairy sector key informants alike that it was very difficult to become a member of Dos Pinos, as they were not seeking any new associates. A producer explained:

“To become an associate, it is necessary to have a minimum of five shares to enter Dos Pinos. But, it is necessary to buy them from another associate who surrenders them; one can only enter if someone leaves. It’s very difficult to join. It is very protected.”

In addition, Dos Pinos shares were perceived to be prohibitively expensive. The “cost of shares” was the most common reason given by producers for not being in a cooperative (cited by over 70% of survey respondents not in cooperatives), and for not selling in a modernized dairy value chain (cited by 63% of those selling in traditional markets). A regional agricultural extension worker explained:

“Those who are linked to Dos Pinos, in my opinion, are privileged producers because the company brings them concentrate [high energy cattle feed supplement], the company gives them technical assistance, the company collects their product at the farm, processes it, and pays them weekly. A small producer... has to negotiate all of these things for himself.”

Given high share prices, it is likely easier for producers who are already better off to access Dos Pinos when rare opportunities do become available. Thus, the cooperative may be reinforcing existing inequality by benefiting those dairy producers who were already better off. It is possible that the cooperative nature of Dos Pinos reinforces this inequality more than a company like Sigma that is further along the spectrum towards “Seek”. Engaging with a specific group of farmers makes the supply relationship personal for Dos Pinos, which likely incentivizes investment in their producers; but it also means there is also a distinct out-group of producers to whom Dos Pinos feels no obligation and little interest. By contrast, Sigma spoke about needing to invest in suppliers to maintain the quality of the supply pool generally; while their producer

supports presumably target current suppliers, their short, one-month contracting arrangements suggest there is greater potential for these investments to be spread around a larger number of producers.

Exclusion and reinforcement of inequality may be characteristic of cooperatives more broadly. In San Carlos, Coopeleche, like Dos Pinos, said they met supply needs via investments in their existing members rather than seeking new members. As such, producers reported it was also very difficult to buy shares and join Coopeleche. Producer cooperatives have been found to exclude poorer producers in other places and in other sectors, and tradeoffs have been found between cooperative marketing success and inclusiveness (Bernard and Spielman, 2009; Ito et al., 2012). This effect may also be reinforced by the fact that firms in modern value chains often seek out cooperative suppliers to reduce transaction costs and secure minimum levels of supply and quality (Barrett et al., 2012). However, exclusion from cooperatives may not mean that non-participants are excluded from all benefits. Non-cooperative members have been found to benefit from high cooperative market share in the dairy sector in Europe (Bijman et al., 2012); further research would be needed to explore whether this is also the case in Costa Rica.

Unequal access to cooperatives is important in light of concerns that modern agrifood value chains can exclude smaller, less wealthy producers (Barrett et al., 2012; Schuster and Maertens, 2013), and increase inequality on a global scale through private standards (Kalfagianni, 2013); particularly if cooperatives exacerbate inequality in modern markets. Maertens et al. (2012) argue that equitable access to modern supply chain benefits will need strategies for creating inclusive supply chains. While it should not be assumed that farmers *should* participate

in modern value chains (see Vorley et al., 2012), arguably, the choice to participate should be widely available, given that equity is necessary for sustainable development (Biermann et al., 2012b) but not automatic (IFAD, 2016).

3.4.3 A good gig going forward?

A second caveat concerns uncertainty over the ability of a cooperative intermediary to sustain producer benefits as it expands its non-production functions. At the time of this study, Dos Pinos and the dairy sector were changing rapidly. Dos Pinos began as a small, localized cooperative of 25 producers; by the time of our study, Dos Pinos had become a multinational exporter with 2600 employees, 1300 producers and a presence in 14 countries (Empresas diamante, 2013). Much of this growth had happened relatively recently: expansion of the firm outside of Costa Rica began in the mid 2000s when Dos Pinos invested in dairy processing and distribution facilities in Guatemala, a first step in a strategy focused on global expansion designed to carry Dos Pinos in the face of increasing competition (Barquero, 2007).

Producers expressed concern about this growth and its implications for their relationship with the cooperative. While Dos Pinos employees described producers as “co-owners” and equals, many producers expressed concerns about inequality as the number of non-producer employees – and co-owners – in Dos Pinos increased. Two different producers explained:

“The cooperative itself has filled with employees who earn. In a department, they have a boss, they have a technician, and the wages are all 250 million [colones] minimum. That’s where the money is going.”

“[Benefits from the expansion of Dos Pinos into new product lines] stay in the company and don’t reach the producers. There is an imbalance, so the quality of life of producers has dropped while that of the people working in Dos Pinos has increased.”

Similar concerns were expressed by most Dos Pinos members interviewed, including those who otherwise seemed quite satisfied with their buyer. Although insignificant, higher proportions of Dos Pinos farmers perceived “Independence in the transaction” and “Ability to negotiate” as challenges in their markets (Figure 3.2) (and conversely, lower proportions of Dos Pinos farmers perceived independence and negotiation as market benefits, Figure 3.1). This may indicate that Dos Pinos producers feel that, despite democratic processes and representation in firm decision making, they are less able to influence their value chain. A more detailed investigation of democratic processes, legitimacy, and representation in the Dos Pinos value chain would be needed to see if the potential for producer engagement in shaping the value chain is being effectively realized in practice, particularly as Dos Pinos expands.

In addition, some producers who had long, multi-generational relationships with Dos Pinos also expressed dissatisfaction with the quality and availability of producer supports available from Dos Pinos; for the first time, these families were considering exiting the cooperative. It is possible these concerns could indicate decreasing investment by Dos Pinos in producer support. Further research would be needed to determine if this is indeed the case.

At the same time that Dos Pinos was expanding, it was experiencing pressure from growing competition. Multiple producers pointed out that Sigma was increasingly pushing into what had traditionally been Dos Pinos areas, and Florida Bebidas had just entered the dairy sector by

buying Coopeleche's processing facilities in 2012. Dairy sector representatives described increasing competition nationally and globally.

Producers explained that milk prices were not increasing at the same rate as input costs, leaving many concerned about decreasing profits, and more than one considering leaving the sector altogether. Dos Pinos said it was making an effort to address this issue through programs designed to help producers decrease costs and increase efficiency. However, at the time of this study, although Costa Rican dairy producers were capturing 15% less of the retail price of dairy products compared to five years prior, the cost of one important input, concentrate (a high energy purchased feed supplement used by almost all commercial producers), had actually dropped in the previous two years (Madriz Carillo, 2014). This suggests that the challenge of decreasing margins may go beyond rising input costs and also involve rising midstream costs in dairy value chains. Further research would be necessary to tease out the flow of costs and income along modern dairy value chains.

Since our study in 2014, these challenges have only increased. Dos Pinos has continued to grow, buying several more dairy processing plants outside Costa Rica, and greatly diversifying its processed food offerings beyond dairy and beverages in 2016 (Barquero, 2016a; Barquero, 2016b). The Costa Rican dairy sector has become more competitive, with additional modernized dairy value chains entering the country, including Mexican multinational LaLa Group (Barquero, 2016c). Towards the end of 2017, global milk prices had decreased (FAO, 2017b). In addition, agricultural systems globally face increasing pressures from climate change (FAO, 2017a). In the face of these changes, it is unclear whether the largely positive relationship Dos Pinos has had

with its suppliers will be maintained. A study revisiting Dos Pinos farmers in San Carlos in 5-10 years would likely be informative.

3.5 Conclusions and future research directions

This paper contrasted the unusual case of Dos Pinos, a producer cooperative that is also a multinational company coordinating a modernized value chain, with other dairy market opportunities, modern and traditional. While our findings are only preliminary, this case provides compelling support for the idea that “cooperative value chain intermediaries”, like Dos Pinos, could provide important benefits to producers participating in modern value chains. We identify two potential challenges with cooperative intermediaries: exclusion of non-member producers from benefits, and challenges to maintaining producer benefits as a cooperative firm’s non-production functions expand.

Further research would be needed to establish causality (see Barrett et al. (2012) for a discussion of common sampling challenges in market participation research) and to confirm trends, in the Costa Rican case, and more generally. A return to San Carlos to collect panel data would likely offer more insights into the ability of a cooperative intermediary to offer sustained producer benefits in a modern value chain.

More generally, the Costa Rican case emphasizes that not all modern value chains are the same with respect to producer outcomes. It suggests that the approach of modernized value chain intermediaries to supplier relationships may have important implications for producer experiences and outcomes. This supports a need for increased research into some of the informal

institutions and mechanisms that shape modern value chain functioning and relationships – like interactions, perceptions, and trust -, alongside the more common formal foci of market participation literature that include contracts, standards, and producer groups. In a review of the economics of food system modernization, Reardon and Timmer (2012) make a case for the need for further research about how firms choose to source from small suppliers, and on the patterns and determinants of their participation. This study suggests that, to understand how participation in modern value chains can most effectively contribute to rural development, it is important to understand not only how firms make decisions about *whether* to source from small farmers, but also, how they make decisions about *how* they approach and engage in these supply relationships and what factors influence the decisions they make. We advocate for research to explore why and under what conditions firms choose different approaches to supply relationships, how those relationships change over time, and how firms might be incentivized to adopt approaches beneficial to their suppliers.

Finally, this research underlines the notion that there is no silver bullet for development - either by connecting producers to modernized value chains or to producer cooperatives. While a cooperative intermediary might bring benefits to participating producers, its overall contribution to rural development may be considerably more tenuous if it concurrently reinforces existing inequality by excluding those who are less well off. Thus, it will be important to continue to pair understanding of how modern value chains can be structured to improve outcomes for participants with understanding of how different value chain structures and institutions influence who can – and who chooses to – participate. With a greater understanding of these dynamics,

modern value chains should hold greater potential to contribute to sustainable rural development at different scales.

Chapter 4: In it for the money? Participation, wellbeing and farming practices in Costa Rica's payments for environmental services program

4.1 Introduction

Environmental or ecosystem services (ES), the benefits that people receive from nature (MA, 2005), provide the framing for many current conservation initiatives. One important implementation is payments for environmental services (PES), broadly understood as mechanisms where ES users and others wishing to support environmental conservation pay for positive incentives to secure desired actions or outcomes from ES providers (Sommerville et al., 2009; Swallow et al., 2009; Wunder et al., 2008). While PES have been widely implemented around the world, and there has been considerable hope that PES might deliver wellbeing benefits for local people in addition to conservation benefits (Grieg-Gran et al., 2005; Wunder, 2008), the uptake and implementation of PES have been impeded by a number of challenges and critiques (Chan et al., 2017a; Kosoy and Corbera, 2010). Many programs have fallen short of their conservation and/or livelihood improvement goals, and programs can favour those who are better off (Anderson and Zerriffi, 2012; Börner et al., 2017; Muradian et al., 2013). There is also concern that PES can impede non-monetary motivations for conservation and shift understandings of rights and responsibilities (Frey and Oberholzer-Gee, 1997; Rode et al., 2015; Vatn, 2010), with a potential for longer-term, difficult-to-measure consequences for sustainability.

Despite these challenges, hope that PES can be useful tools in a movement towards sustainability persists (Chan et al., 2017a). To understand how to address challenges and continue to improve PES implementation, it is important to continue to build our understanding of who participates, why people participate, and what conservation and wellbeing benefits can and should be pursued in different contexts. Many studies of PES consider one or a few wellbeing indicators, often primarily income, and use measures of target ES and their proxies (e.g., sequestered carbon and forest cover) as measures of conservation outcomes. However, wellbeing is a complicated construct that is influenced by many factors beyond income (Ahuvia, 2008; Chambers, 1997; Dolan et al., 2008; Gasper, 2004) and PES programs have the potential for negative unintended spillover effects for non-target ES (Bremer and Farley, 2010; Farley et al., 2005; Wunder, 2005). Accordingly, when assessing PES programs, it is arguably prudent to take a broader approach to wellbeing and to consider conservation effects beyond target ES.

Seeking a more nuanced understanding of the connections between PES participation and wellbeing and environmental outcomes, we conducted surveys and interviews with a group of cattle farmers in Costa Rica. We investigated a broad range of wellbeing indicators, and considered farming, land conservation practices, and farm management goals as indicators of local environmental wellbeing in order to better understand the relationships between participation in the national PES program and human wellbeing, perceived benefits of participation, and farming practices. In this paper, we present some of our findings, discussed in the context of three specific concerns about PES: (1) that programs tend to favour those who are already better-off; (2) that participation in PES may impede non-economic motivations for conservation; and (3) that programs often exclude those who are already engaged in conservation

behavior, or offer little additional conservation benefit. We discuss the implications of our findings for how PES is approached and implemented.

4.2 Materials and methods

4.2.1 Case study: Cattle farmers in San Carlos, Costa Rica

This study was conducted in the southern part of the cantón of San Carlos (Figure 1.4), an agricultural cantón of close to 165,000 people (INEC, 2012) located north of the capital San José in the province of Alejuela, Costa Rica. To allow us to compare responses to questions about particular farming practices, we focused on dairy cattle farmers. Based on conversations and data from local researchers and informants San Carlos was selected because it is a dairy farming region with a comparatively high level of PES participation.

San Carlos' population is more than 50% rural, compared to a national rate of only about 25% (INEC, 2012) and is concentrated in the south of the canton around Ciudad Quesada, the region's major commercial centre. Agriculture is a major economic activity. Approximately 64% of the canton's land area is farmland (INEC, 2015). Important agricultural enterprises include cattle (particularly dairy - San Carlos is home to just over a quarter of Costa Rica's dairy cattle), as well as pineapple and yucca (with the region producing approximately a third of Costa Rica's total production of each) (INEC 2015). The region also engages in commercial forestry (INEC 2015). For more information on the study area, please see Chapter 1.

4.2.2 PES in Costa Rica

Beginning operation in 1997, the Costa Rican national PES program (el Programa por Pago de Servicios Ambientales) is one of the longest-running PES programs in Latin America. The program is managed by the Fondo Nacional de Financiamiento Forestal (FONAFIFO) a branch of the Ministry of Environment and Energy in the federal government. It uses contracts to secure five types of land uses – forest protection, commercial reforestation, agroforestry, sustainable forest management, and regeneration – which are understood to provide four bundled categories of forest ecosystem services (ES) – greenhouse gas mitigation, hydrological services, biodiversity protection, and scenic beauty (FONAFIFO, 2017a; Porras et al., 2013). The most common contracted land use by far is forest protection, representing nearly 90% of land in the PES program at the time of this research (FONAFIFO, 2016a). In San Carlos, forest protection is the most common modality, followed by reforestation (FONAFIFO 2017b). Most contracts are with landowners owning 1- 300ha (FONAFIFO, 2016b). Since 2011, protection contracts have been awarded disproportionately to areas with higher conservation priority and a lower human development index, and to smaller properties (Porras et al., 2013). The director of FONAFIFO's PES program explained in an interview that applications for reforestation, regeneration and agroforestry contracts are generally all approved providing legal and administrative requirements are met.

With the assistance of local intermediaries, landowners sign contracts with FONAFIFO that specify how land will be managed to generate ES credits, to which FONAFIFO owns the rights. Program funds come from government funding, private sector purchases of ES credits, and international banks and organizations. Payments to landowners are per hectare (or per tree in the

agroforestry modality, and vary based on activity, with higher payments being awarded to land uses considered to have higher conservation value (e.g. protecting biological corridors, reforestation with native species, etc.) (FONAFIFO, 2014). Contracts last 5-15 years with contract length and payment schedule depending on the type of land use and the year in which the contract was signed (Porrás et al., 2013). Monitoring is conducted by regional FONAFIFO offices.

In San Carlos, La Comisión de Desarrollo Forestal de San Carlos (CODEFORSA), a sustainable forestry non-governmental organization (NGO), is the main PES intermediary. At the time of this research, CODEFORSA was managing more than 400 active PES contracts in San Carlos, with a small number of additional contracts facilitated by independent forestry engineers and the Instituto Costarricense de Electricidad (ICE), Costa Rica's government-run electricity and telecommunications provider.

4.2.3 Sampling, data collection and analysis

We conducted household surveys at 217 cattle farms within a 2-hour drive from Ciudad Quesada in April and May of 2014. Of these, 37 farms were participating in PES at the time of data collection. Farms were involved in protection, reforestation and agroforestry modalities. The protection modality was by far the most common, involving 32 farms. Several farms had contracts for multiple modalities.

Multistage sampling was used to sample cattle farms within regions centred on selected communities in San Carlos. PES participants in San Carlos tend to be closer to Ciudad Quesada

where most PES intermediaries are based. To ensure we surveyed a sufficient number of PES participants from a relatively small sub-population, we cross referenced data about PES participants and cattle farmers to identify areas with higher numbers of dairy farming PES participants. Within these sample areas, PES participants were targeted to ensure a sufficiently large subsample of PES participants. Other dairy farmers were sampled randomly using information from SENASA. Due to farm classification errors in the SENASA data that directed us to multiple PES participants that were primarily meat cattle operations, we included a small handful of meat cattle farms (eight in total), both PES participants and non, in order to increase our sample of PES participants. Please see Chapter 1 for additional information about sampling and data collection in this study.

We performed statistical analysis of survey data using R software. A wealth index was constructed as a proxy for wealth using household and productive asset data as per the method described by The Demographic and Health Surveys Program (DHS), which uses the first component from principal components analysis to weight assets (Filmer and Pritchett, 2001; Rutstein and Johnson, 2004). While not equivalent to household income or expenditure measures, asset-based wealth indices are common in development research, and have been demonstrated to be useful proxies of wealth and long-term economic status for developing country households (Filmer and Pritchett, 2001; McKenzie, 2005; Michelson et al., 2013; Rutstein and Johnson, 2004). In some cases, wealth indices may even be preferable to income and expenditure measures, particularly where recall bias is likely and accurate household income and expenditure data are particularly difficult to obtain – for example, where income is seasonal, as in farming households, or highly irregular, as in many poorer households (McKenzie, 2005;

Michelson et al., 2013; Rutstein and Johnson, 2004; Sahn and Stifel, 2000). Our survey also asked about household income, but the majority of participants declined to answer the question. Local researchers with experience working with farmers in Costa Rica informed us that questions about income are generally regarded with suspicion and frequently not answered, or answered inaccurately.

For this paper, we analysed our data to explore three questions: (1) What are the characteristics of PES participants in San Carlos? (2) Why are people participating in PES? What benefits do they perceive and/or are there any significant differences in their wellbeing compared to non-participants? and (3) Does PES participation correlate to differences in conservation and farm management practices? We interpreted all of our analyses in light of the three concerns about PES listed above.

To explore who participates in PES in San Carlos (1), we compared household and farm characteristics for PES and non-PES groups. We used proportion tests to compare proportions for binary variables, substituting a Fisher test wherever any count was less than 10. Fisher tests were used for categorical variables. We used t-tests to compare means for continuous variables, substituting a Wilcoxon test to compare population shape for non-normal distributions. P-values were adjusted using the Benjamini Hochberg method to control the False Discovery Rate across multiple tests (Benjamini and Hochberg, 2000; 1995; Krzywinski and Altman, 2014). To understand why people are participating in PES and what wellbeing benefits they experience (2), we used a similar procedure to compare wellbeing variables for PES and non-PES groups. We also explored patterns in data for PES participants alone to see if there were differences in

perceived benefits of PES participation to see if participants with different characteristics appear to participate for different reasons (2). Due to the low sample size, we used cross-tab tables to compare PES participants. We again used a similar procedure to explore how PES participation correlates to farm management and conservation practices (3) for PES and non-PES groups.

Then, to further explore what factors are correlated with PES participation versus conservation generally (1, 2), and to explore what factors correlate to higher percentages of land being conserved, we performed exploratory regression analyses. Percent land being conserved was calculated by asking farmers how many hectares they owned, and how many hectares they had in various land uses (pasture, conservation land, commercial forestry, etc.), and then dividing the amount of conservation land by the total hectares owned. We constructed logistic regression models with binomial distributions for PES participation and conserving land, and a linear model for percent of land conserved. A global variable set was selected for all three regressions based on the literature and correlation matrices constructed for the three variables. We used the variance inflation factor (VIF) to examine multicollinearity in our models and used stepwise removal of variables until all terms in the model had VIF less than two (Zuur et al., 2009). We used a stepwise function to select best-fit regression equations for each variable based on Akaike information criterion (AIC) (Akaike, 1992; 1981).

All survey results were interpreted in the context of qualitative analysis of data from multiple meetings and a set of 20 formal semi-structured interviews with key informants conducted from March to May 2014, including five cattle and dairy industry representatives, two agricultural extension workers, the director of FONAFIFO's PES program, three PES intermediaries, and ten

producers identified as “community leaders” by agricultural extension workers and fellow producers (i.e., producers with considerable knowledge of the experiences of others in their communities, usually by virtue of being actively involved in community organizations). Producers interviewed included both PES participants and non-participants and represented a diversity of dairy farming experiences with respect to markets, farm size, location, etc. Qualitative data was used in conjunction with insights from the literature to build hypotheses explaining quantitative findings.

4.3 Results and discussion

4.3.1 Who participates in PES? Adding nuance to the idea that PES favours the wealthy and educated

Multiple studies suggest that those who are better off often have greater access to and benefit more from PES (Börner et al., 2010; Grieg-Gran et al., 2005; Pagiola et al., 2005). Despite having equity goals, Costa Rica’s PES program has been found to favour wealthier and more educated landowners, while excluding many smaller and more vulnerable landowners (Ortiz Malavasi et al., 2003; Porras et al., 2013; Zbinden and Lee, 2005).

Echoing Ross (Ross, 2016), we did not find a significant difference in median wealth index between PES participants and non-participants (Table 4.1). However, we suspect that our index did not effectively capture wealth differences among farmers because it included a variable set designed to capture wealth in the general population, rather than our focus subgroup (dairy farmers) (please see Appendix B for a more thorough discussion). Supporting this idea, we found significant differences in variables suspected to be proxies for wealth. These include hectares

owned, distance and travel time to the major commercial centre (Table 4.1), and living off farm (Figure 4.1). Coupled with participants' feelings that payments were very low, this suggests that greater wealth does appear to facilitate PES participation in San Carlos. We also found PES participants had been cattle farmers and farming their current farmland significantly longer than non-participants, suggesting that stability may also facilitate PES participation (Table 4.1).

Table 4.1 Comparison of characteristics of PES participants to non-participants.

	Test	Participate in PES mean (t-test) or median (Wilcoxon) (N=37)	Don't participate in PES mean (t-test) or median (Wilcoxon) (N=181)	95% Confidence Interval for difference between means/medians	Significance Based on p-values adjusted with Benjamini-Hochberg correction
Wealth Index	t-test	2.09	-0.444	(0.135, 4.94)	
Hectares owned	Wilcoxon	80.0	20.0	(20.5, 91.0)	***
Years farming cattle	t-test	31	24	(2.0, 12.6)	**
Years farming on current land	t-test	32	24	(3.5, 14.4)	***
Travel time to major centre (min)	t-test	41.6	52.5	(-17.8, -3.3)	**
Distance to major centre (km)	t-test	24.0	33.2	(-15.9, -2.5)	*

* p<0.05 ** p<0.01 *** p<0.001

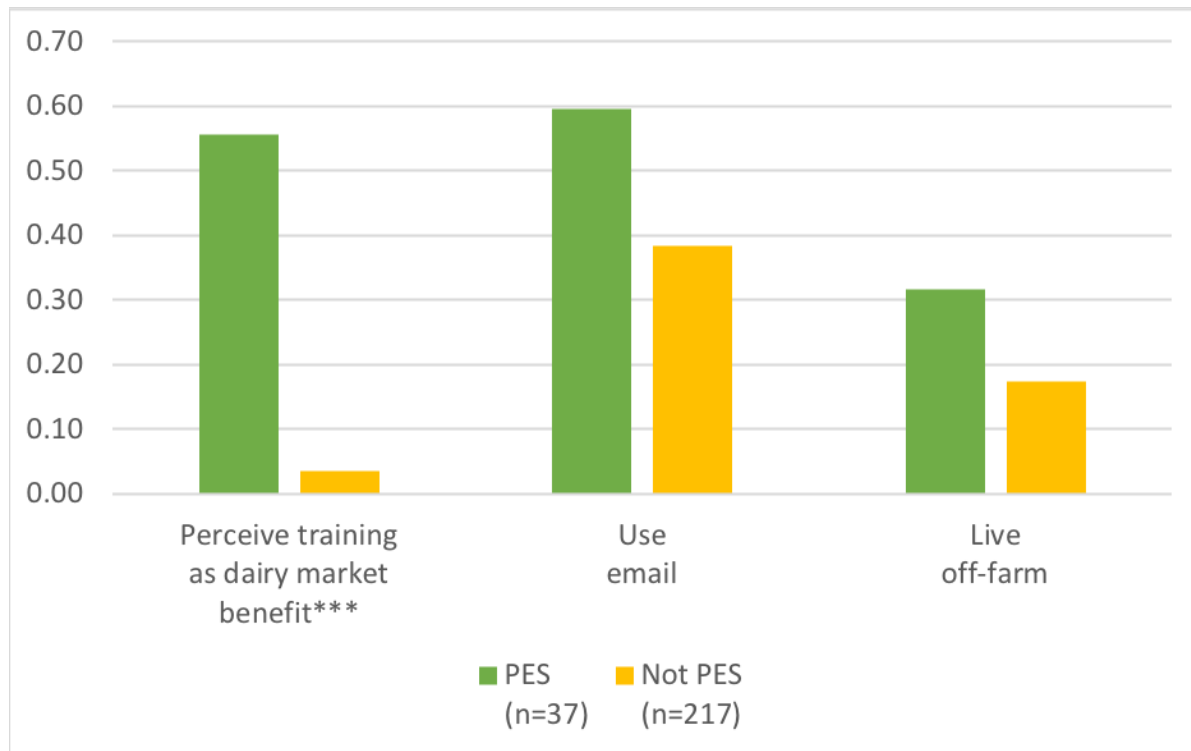


Figure 4.1 Characteristics of PES participants and non-participants. Significant differences indicated in axis label based on p-values adjusted using Benjamini-Hochberg correction (* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$).

Our data are in line with previous studies of PES in Costa Rica that found participants tend to be more educated (Porrás et al., 2013). However, like Ross (2016), none of these apparent differences in education were statistically significant (Figure 4.2). However, PES participants in San Carlos may have different attitudes towards learning and novelty compared to non-participants. More than 50% of our PES participants perceived “access to training opportunities” as a benefit of selling into their current dairy market, compared to less than 5% of non-participants (Figure 4.1). This suggests that PES participants value educational opportunities. While not significant, PES participants were also more likely to use email, and less likely to produce the same farm products every year (15% of PES participants “Sometimes” or “Usually” change their farm products annually, compared to 2% of non-participants).

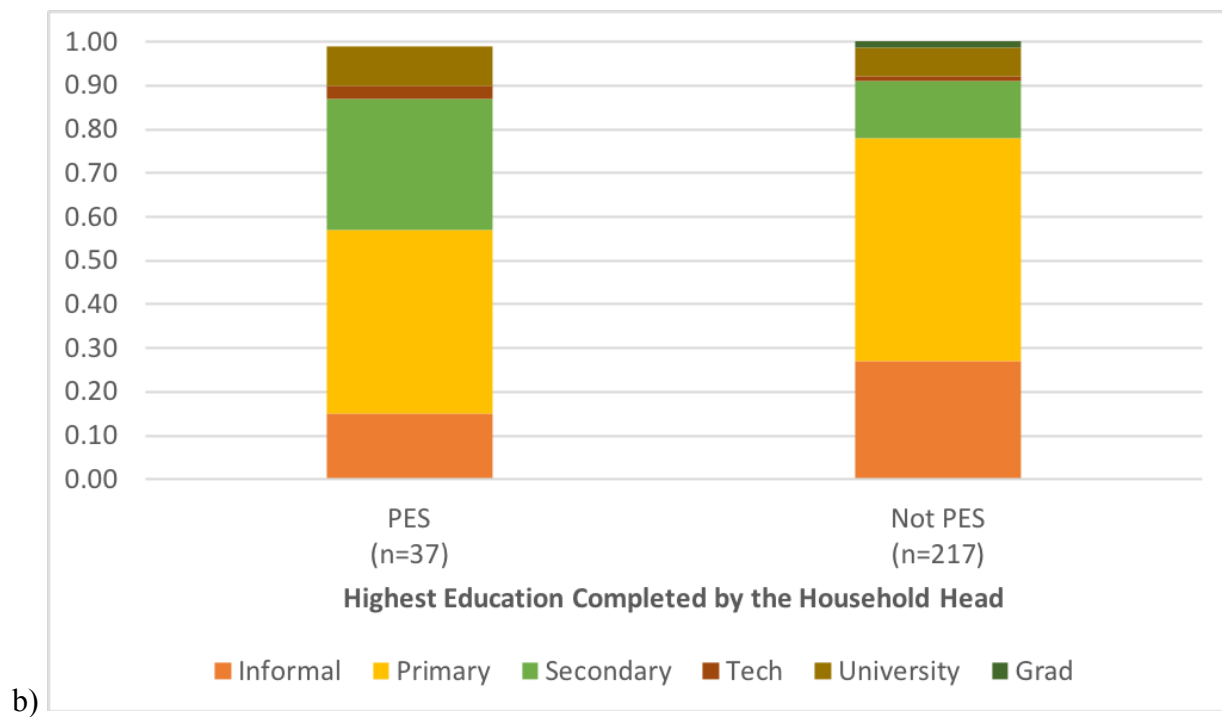
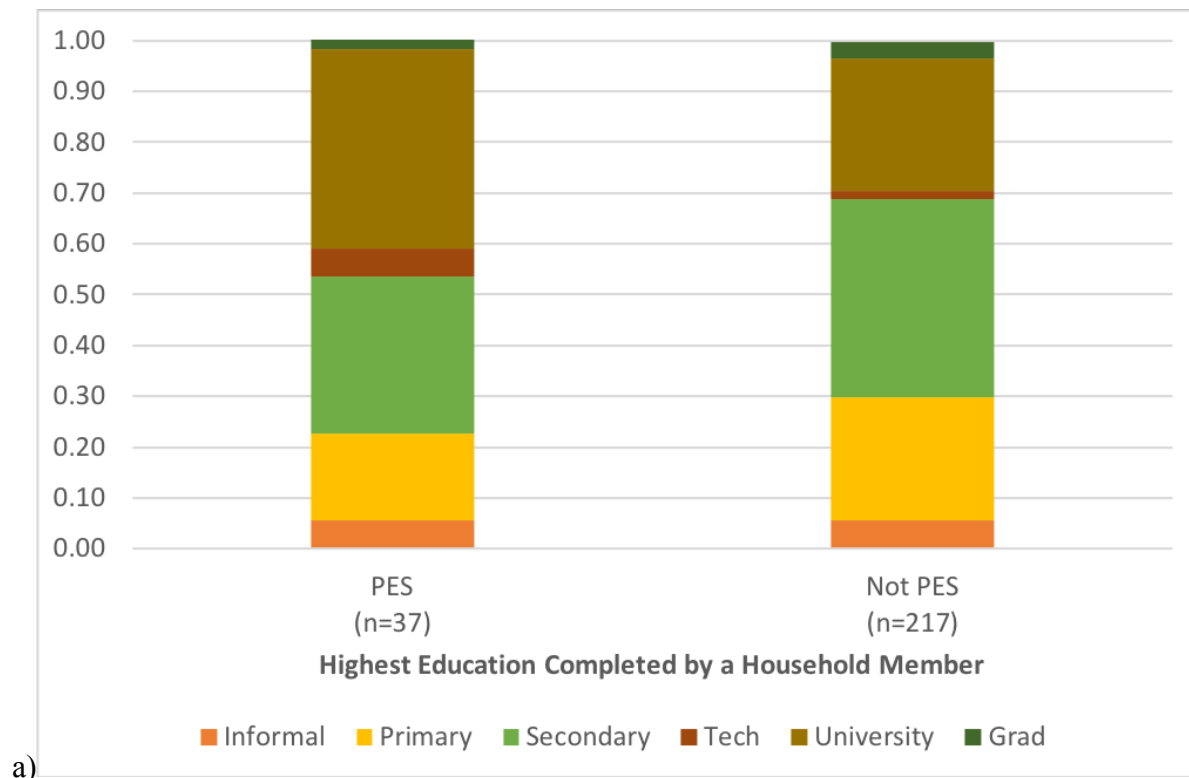


Figure 4.2 Comparison of household education of PES participants and non-participants. Shows highest level of education completed by (a) any household member and (b) the household head.

These findings are supported by an exploratory regression analysis comparing best-fit explanatory variables for PES participation, conservation participation, and percent of land being conserved (Table 4.2). PES participation is positively correlated to a number of variables that suggest PES participants may be more open to learning and experimenting with novel technologies and practices: perceiving training opportunities as a dairy market benefit, using email (a relatively new technology in rural Costa Rica), and using a greater number of different information sources to inform their farm management.

This finding that PES participation was connected to attitudes towards learning and novelty than to education suggests that the literature on agricultural innovation might provide insight into PES participation. The adoption of novel agricultural practices and technology has also been linked to attitudes towards learning, experimentation and novelty (Cavallo et al., 2014; Dunn et al., 2016), as well as to risk attitudes (Dercon and Christiaensen, 2011; Marra et al., 2003), learning and information (Marra et al., 2003), and to household characteristics including cooperative membership (Abebaw and Haile, 2013), access to agricultural education and financial capital (Lambrecht et al., 2014; Läpple et al., 2015), social capital (Lambrecht et al. 2014), and farm size (Brown et al., 2016). Drawing on the agricultural innovation literature, future research exploring the process of PES uptake, and the characteristics of “early adopters” of PES and how they might be leveraged to bring others to participate, could provide insight into how to better-target and increase participation in PES, and thus, improve associated wellbeing and equity outcomes.

In contrast, controlling for PES participation, conserving land is predicted by a number of variables that suggest conservation behavior is more strongly linked to factors we hypothesize increase stability and buffer risk, including living off-farm (indicating access to off-farm income and/or greater wealth), having a greater number of household income sources, and having a larger number of farm workers (Table 4.2). PES participation is a positive predictor of conservation; however, the effect size is not large (Table 4.2). Notably, conservation is also negatively correlated to how easily farmers perceive they can change their dairy market (i.e., controlling for PES participation, farmers who are conserving perceive changing their dairy market to be more difficult). We hypothesize that this variable may reflect attitudes towards novelty and experimentation; farmers who are conserving but not participating in PES may perceive change to be more difficult (and may thus be more resistant to trying PES). More research would be necessary to confirm this hypothesis. These findings imply that conservation generally might be increased in part by supporting farmers to achieve greater stability in their farming operations. Given the contrast in significant predictors of PES participation versus conservation, it should not be assumed that facilitating conservation will increase PES participation.

Many other studies of PES in Costa Rica have found participation to be linked to one particular indicator of wealth—farm size (Miranda et al., 2004; Ortiz Malavasi et al., 2003; Porras et al., 2013; Ross, 2016; Zbinden and Lee, 2005). In a regression equation predicting the percent of land conserved by farmers in San Carlos, PES participation has a large effect size while hectares owned has a small effect size (Table 4.2). Hectares owned is not a significant predictor of PES participation. Together, this suggests that PES participation is more strongly linked to the

amount of land that farmers are able to set aside for conservation rather than to the total amount of land owned. For example, if a farmer owns a large amount of land, but feels he or she are only able to commit a small proportion of his or her land to non-agricultural activities, he or she may actually be less likely to participate in PES compared to a farmer owning less land, but who is willing and able to have a larger proportion of that land in non-agricultural uses. CODEFORSA, the main PES intermediary in San Carlos, explained in an interview that contracts involving 10-20 hectares are not profitable because they involve the same level of fixed administration costs as larger projects. FONAFIFO similarly explained that, while the minimum land requirement to participate is only two hectares, PES payments on two hectares would not cover transaction costs. This implies that PES participation by farmers with less land might be increased by facilitating improvements in production efficiency to free up land (e.g., via training to improve pasture management). Participation might also be increased by changing the cost structure to lower fixed costs, or by incentivizing more activities like agroforestry (e.g., other more sustainable agricultural practices) that could be adopted in conjunction with productive land uses.

Table 4.2 Results of exploratory regression analyses comparing best-fit equations for PES participation vs. participation in conservation vs. percent land conserved. Odds ratios with 95% confidence intervals are reported for binary variables (PES and Conservation participation). Coefficients with 95% confidence intervals are reported for continuous variables (Amount land conserved). Only respondents conserving land were included in the regression predicting Amount Land Conserved.

DEPENDENT VARIABLE	PES Participation (Y/N) (n=153)	Conservation Participation (Y/N) (n=153)	Amount Land Conserved (%) (n=64)
EXPLANATORY VARIABLES	ODDS RATIO (95% CI)		COEFFICIENT (95% CI)
Intercept	-4.15*** (-6.8, -1.9)	0.242 (-1.5, 2.0)	-7.37 (-16, 1.7)
PES participation	N/A	2.06** (0.80, 3.5)	17.7*** (10.6, 24.7)
Live on-farm	-1.54 [†] (-3.2, 0.0086)	-1.10* (-2.3, -0.026)	-
Hectares owned	-	-	0.0326* (0.0060, 0.066)
Training perceived as a benefit of current dairy market	3.88*** (2.3, 5.8)	-	-
Use email	1.55* (0.16, 3.1)	-0.813 [†] (-1.7, 0.049)	-
Cattle density (cattle per hectare pasture)	-0.254 (-0.70, -0.011)	-	1.28** (0.74, 1.8)
Changing dairy markets perceived to be easier	-	-0.558* (-1.0, -0.14)	2.89 [†] (-0.53, 6.5)
Years farming current farm	-	-0.0260 [†] (-0.057, 0.0026)	0.15 (-0.062, 0.36)
Years cattle farming	0.0732** (0.023, 0.13)	-	-
Number of information sources informing farm management	1.1 [†] (-0.040, 2.4)	-	4.63* (0.72, 8.5)
Number of household income sources	-	0.353* (0.020, 0.71)	-

DEPENDENT VARIABLE	PES Participation (Y/N) (n=153)	Conservation Participation (Y/N) (n=153)	Amount Land Conserved (%) (n=64)
EXPLANATORY VARIABLES	ODDS RATIO (95% CI)		COEFFICIENT (95% CI)
Years selling in current dairy market	-0.00443 (-0.11, 0.011)	-	-0.154 (-0.35, 0.043)
Total farm workers (including family)	-	0.157* (0.028, 0.33)	-
Adjusted R ² +			0.5222
Cox Snell Pseudo R ²	0.2921	0.2606	

*** p < 0.001 ** p < 0.01 * p < 0.05 † p < 0.1

+ Adjusted R² > 0.2 indicates very good model fit in social science research (Louviere et al., 2009).

4.3.2 Why do people participate in PES? Capturing non-monetary motivations

Although we found no evidence of significant differences in numerous wellbeing indicators between PES participants and non-participants, only two participants indicated that they experienced no benefits from participation (Figure 4.3), and many had renewed contracts. More generally, FONAFIFO has observed increasing PES contract applications despite decreases in the real value of PES payments (Porrás et al., 2013). In line with the conclusions of others (Kosoy et al., 2007; Ortiz Malavasi et al., 2003), this suggests to us that people feel they are benefiting from participation in PES, and that intangible benefits may be playing an important role in motivating participation.

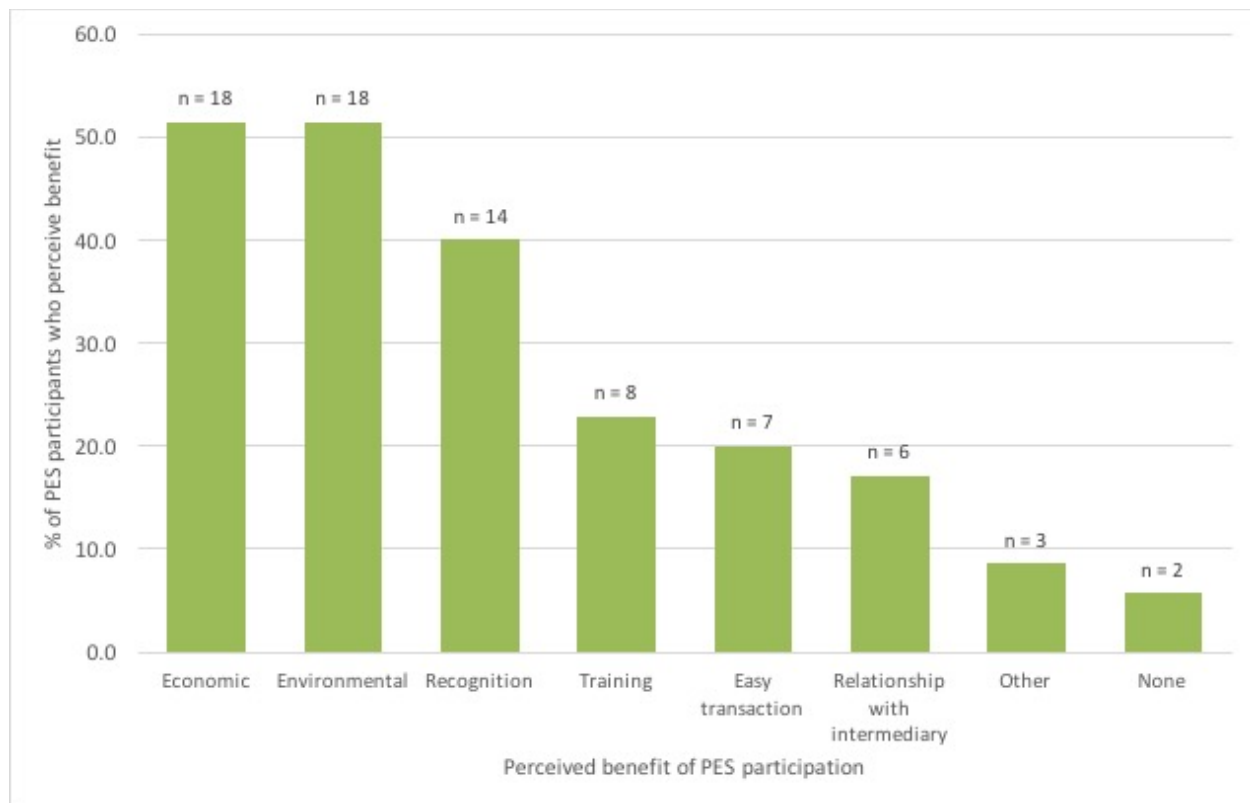


Figure 4.3 Perceived benefits of PES participation as identified by interviewees. “Recognition” corresponds to “Recognition as someone who cares for the environment”. Respondents were requested to “Select all that apply”. Overall, 28% of participants perceived both Environmental and Economic benefits; 71% of participants perceived Environmental and/or Recognition benefits.

While, as we argued above, it seems likely PES participants tend to be wealthier, we suspect that wealth facilitates PES participation, rather than PES contributing significantly to household wealth. PES payments were widely considered to be low, with one third of participants identifying the amount paid as an important challenge in the program. Nevertheless, 51.4% of PES participants surveyed perceived economic benefits to participation (Figure 4.3). For some, PES was seen as a relatively low-effort way to make some money from otherwise unprofitable land. One participant said: “For one who owns land that doesn’t have lumber, that because of its topography can’t be worked and is useful for almost nothing, it’s better to have these contracts

and receive extra income.” However, while the opportunity cost of putting land into PES for some Costa Rican land owners may be effectively zero because the land does not have other economic uses, participation in PES nevertheless has other costs, like administrative and time requirements. In addition, PES income was not the most important household income stream for anyone surveyed, and made the top three most important household income streams for only slightly more than 50%, suggesting economic returns from PES are not high. While economic motivation is by no means unimportant, for most PES participants, it would seem that monetary gain was not the exclusive, or indeed necessarily the primary, motivator for their involvement in the program. Given the low monetary returns from PES and the costs of participating, it seems likely that intangible benefits are a factor in motivating PES participation in San Carlos.

Many participants perceived non-monetary wellbeing benefits, such as access to training opportunities (22.9%) and the relationship they had with the PES intermediary (17.1%). Notably, non-monetary motivations connected to environmental values were more widespread than economic motivations. Just over half of PES participants perceived environmental benefits of participation – the same number as perceived economic benefits – while 40% reported benefits from “recognition as someone who cares for the environment”. Altogether, 71% of PES participants surveyed perceived environmental and/or recognition benefits, suggesting that the majority of participants were motivated to participate at least in part because of their environmental values. Notably, only 6 participants (17%) perceived economic benefits without environmental or recognition benefits. An interviewee identifying environmental and recognition benefits described his motivation for participating in PES by saying “Why do I participate? Because I am conscious of the need to care for the environment, and the need to conserve the

forest.” He went on to describe how the PES payments are “totally symbolic”, and he could make much more money from the land he has in PES by using it in other ways. However, he feels an obligation to conserve, and to do so in a public manner that demonstrates to others that he believes this is important.

Those perceiving environmental and recognition benefits may be motivated at least in part to participate in PES because it gives them opportunities to act on and communicate environmental values, and/or because participation reinforces their identities and values. Other studies of PES in Costa Rica have reached similar conclusions. For example, only 10% of PES participants in a study by Ortiz et al. (2003) thought that PES helped landowners economically, but most felt that PES contributes to conserving nature (88%) and biodiversity (91%). They found that “emotional benefits”, linked to satisfaction associated with ideas like identifying as a “conservationist”, fulfilling perceived responsibilities to conserve forest, and meeting social expectations, far outweighed economic benefits. Similarly, Arriagada et al. (2015) found no evidence of tangible wellbeing benefits of participation in PES, but more than 50% of participants identified environmental protection as an important motivation. They concluded that many farmers “participated in order to gain recognition for their conservation efforts, which ... gave them a ‘warm glow’ from conserving forest” (Arriagada et al, 2015, p.14). Despite this recurring theme in PES studies that values and non-monetary motivations are important, most PES programs and research continue to focus on tangible benefits and economic aspects of the transaction, like opportunity costs and levels of compensation.

Our data also suggests that heterogeneity in participant characteristics may be important as they will perceive different benefits of participating in PES. Participants selling into local dairy markets were more likely to perceive environmental benefits without economic benefits, while non-dairy cattle farmers were more likely to perceive economic benefits without environmental benefits (Figure 4.4a). Those participating in the Reforestation modality were more likely to perceive economic benefits without environmental benefits (perhaps because payment levels in this modality are relatively higher), while those participating in Protection were more likely to perceive environmental benefits without economic benefits (Figure 4.4b). Generally, PES participants who perceived environmental benefits without economic benefits tended to be wealthier, live closer to the nearest commercial centre, and have spent longer cattle farming, on their current land and in their current market (Figure 4.5). This suggests that those with stronger economic motivations may be more likely to participate in modalities with the potential to generate additional income or to be implemented in parallel with income-generating land uses, while participation in protection modalities may be easier for those with greater wealth and stability. Other studies of PES in Costa Rica have found that smaller landowners tend to rely more heavily on PES income, and that protection modality participants tend to be wealthier and own more land (Ortiz Malavasi et al., 2003; Zbinden and Lee, 2005). We hypothesize that for those who perceived important economic benefits, circumstances may have made money a more central consideration (rather than their environmental motivations being less important). For example, less wealthy participants or those with less land may need to realize higher returns per unit of their land, or be relying more heavily on income from PES as a proportion of their household income. Similar suggestions have been put forth by others (Muradian et al., 2010; Ross, 2016; Zbinden and Lee, 2005).

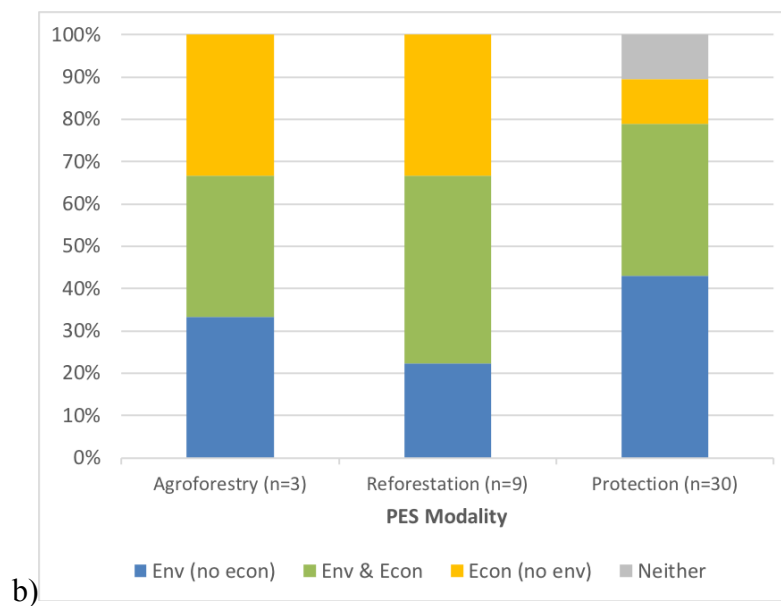
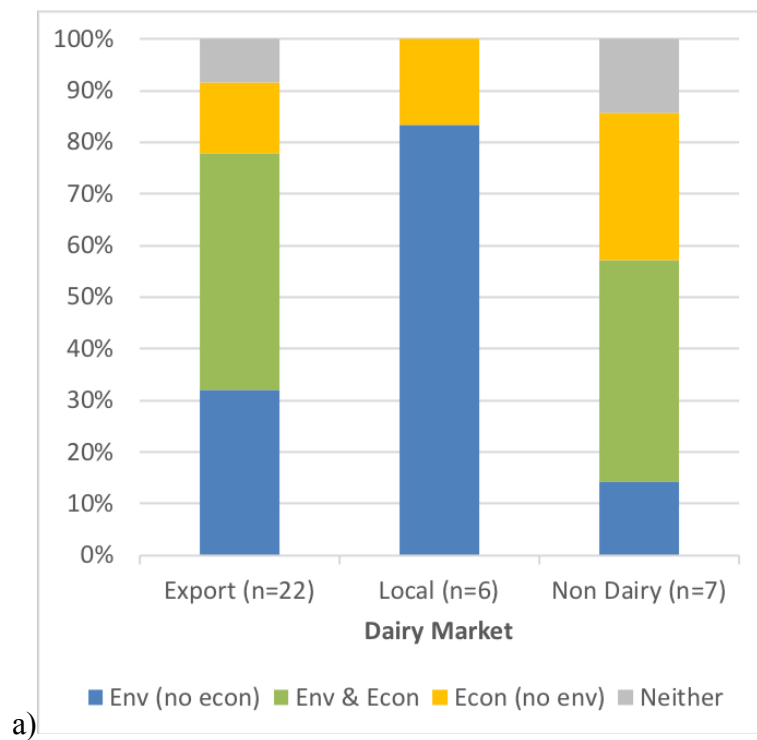


Figure 4.4 Proportions of farmers who perceive different benefits of participating in PES who are selling into (a) different markets and (b) participating in different PES modalities. “Env (no econ)” refers to those perceiving environmental but not economic benefits; “Econ (no env)” refers to those perceiving economic but not

environmental benefits; “Enviro & Econ” refers to those perceiving both environmental and economic benefits; “Neither” refers to those perceiving neither economic or environmental benefits.

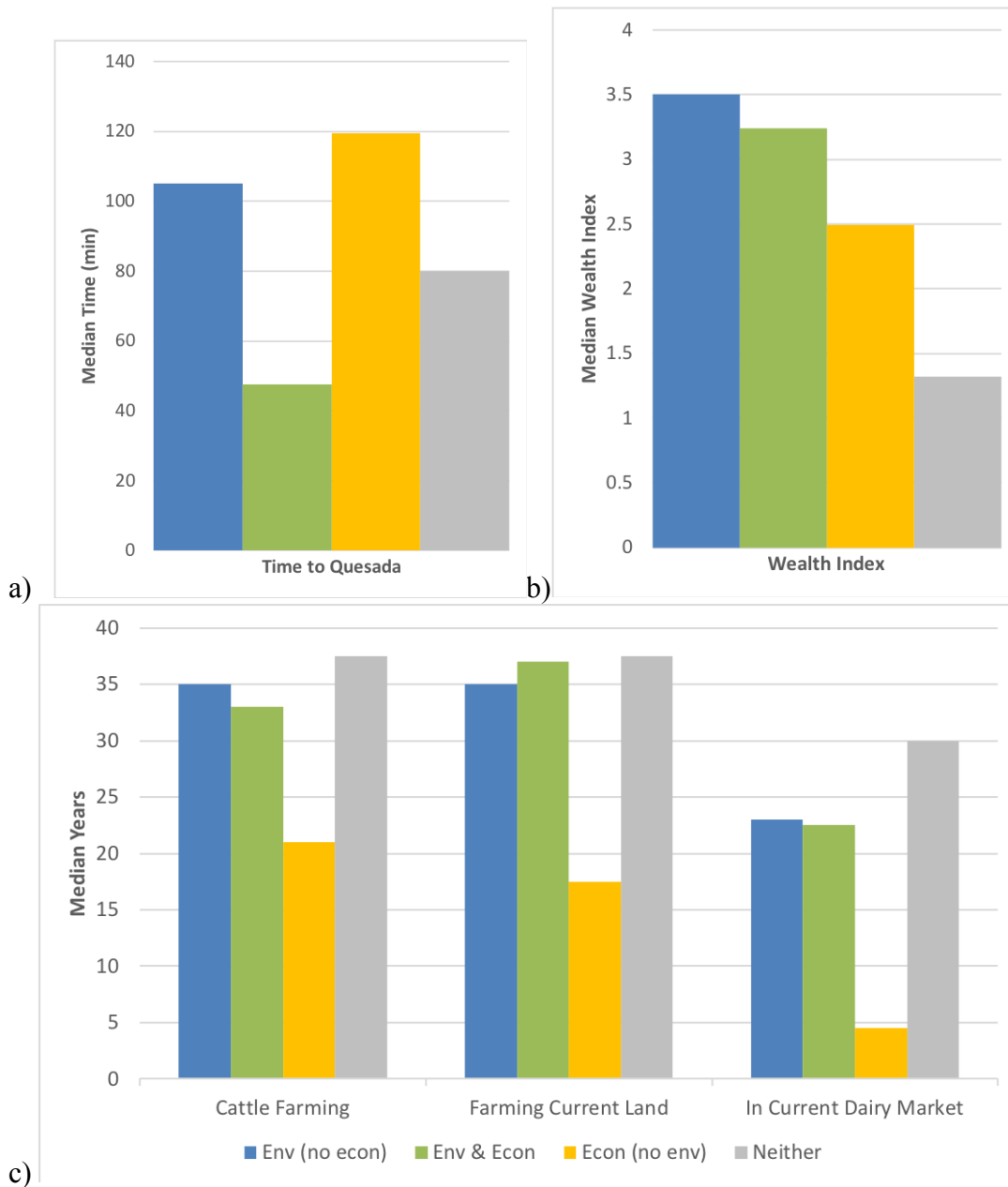


Figure 4.5 Comparison of characteristics of PES participants perceiving different benefits of PES participation: (a) Travel time to Quesada, the major commercial centre in the region; (b) Wealth; and (c) Years the farmer had been cattle farming, farming their current land, and selling in their current dairy market.

We see two main implications of these findings. First, the fact that a majority of PES participants appear to be motivated at least in part by environmental values suggests an opportunity to design PES to harness these motivations, with a potential to secure lower cost conservation. Evidence suggests that concerns that PES have the potential to crowd out non-economic motivations for conservation are justified (Rode et al., 2015); however, our findings support the notion that PES can also crowd in motivations (Lapeyre et al., 2015; Rode et al., 2015), and could be explicitly designed to work with, support, and reinforce existing environmental values (Chan et al., 2017a; 2016). Such a program might have a relatively low impact on tangible income or asset measures of wellbeing, but could contribute intangibly to wellbeing through mechanisms like social recognition, identity reinforcement, and satisfaction linked to the ability to act on and communicate conservation values.

This approach has the potential to address two common critiques of PES – that programs are costly, and that PES can impede non-economic motivations for conservation and shift responsibility. Many authors suggest that PES payments should reflect the opportunity cost of alternative land uses (e.g., Grima et al., 2016; Wunder, 2007). While this makes conservation the most economically viable land use and helps secure additional conservation (i.e., conservation that wouldn't have happened in the absence of the program), it can make PES programs very costly and difficult to implement where alternate land uses are highly profitable. Economic incentives can impede non-material motivations for conservation and shift understandings of responsibility towards ecosystems (Chan et al., 2012). As described by Chan et al. (2017a), PES could be designed to use below opportunity cost and/or non-monetary incentives to help people to do things they wanted to do anyway, thereby lowering conservation costs and limiting the

potential for crowding out non-economic motivations. As mentioned above, there is evidence that Costa Rica's PES is already acting in this way, at least in some areas, with studies reporting sustained participation despite low payments, and participants describing how PES participation is emotionally satisfying and strengthens participants' values connected to forests (Arriagada et al., 2015; Legrand et al., 2013; Ortiz Malavasi et al., 2003). This idea that PES participation can be driven at least in part by values and non-economic motivations, including intrinsic motivations and cultural practices, echoes others (see Muradian et al., 2010); yet most PES programs and discourse remain focused on opportunity costs and material benefits as motivators and target outcomes. Indeed, the larger class of such programs is called "economic incentive programs".

The second implication of our findings is that PES program targeting and uptake might be improved by having a better understanding of the motivations of different potential participant groups. For example, for those who are motivated by environmental values but for whom economic returns are also necessarily important (e.g., those who are less wealthy), PES advocates could explain to potential participants how PES might form part of a viable portfolio of income streams supporting a small farm household. It might make sense to focus on modalities like reforestation and agroforestry that hold the potential for additional income and/or parallel income-generating land uses. Flexible PES designs, like reverse auctions where potential participants propose what they would like to do and at what cost (e.g., Stoneham et al., 2003), could help more households with dual economic and environmental motivations to participate by allowing them to propose the conservation actions that have the lowest opportunity cost for them. This could increase the accessibility of PES to less well-off landowners and those with

smaller parcels, without increasing the size of payments and the risk of crowding out intrinsic motivations. In addition, flexible PES designs could also support the adoption of more sustainable agricultural practices. This could be desirable given that we found that PES participation did not correspond to the use of more sustainable practices beyond those directly supported by PES (Chapter 5, this dissertation). Given the importance of framing and language to the desirability of PES programs (Clot et al., 2017), it's likely that a combination of incentives, communicated appropriately to appeal to the specific motivations and needs of different sub-populations, will be helpful in making PES both attractive to and viable for the greatest diversity of participants.

4.3.3 PES and farming practices: Is additionality always the best target?

Many authors advocate for establishing baselines and measuring additionality (meaning ES are being generated or protected that would not have been in the absence of PES) in order to measure the success of a PES program (e.g., Grima et al., 2016; Sommerville et al., 2009; Wunder, 2007). We found that PES participants in San Carlos were significantly more likely to set aside land for conservation (two-sided proportion test, $p < 0.05$ after BH correction), and set aside significantly larger percentages of their land for conservation (two-sided Wilcoxon test, $p < 0.001$ after BH correction). However, our results do not establish causality. Our interviews suggest that in at least some cases, PES participation was not incentivizing additional conservation but rather, people were participating because they were already conserving, such that PES income was a bonus rather than an incentive. People with larger amounts of un-farmed land would presumably be more likely to apply for PES as they would enjoy higher returns for their efforts due to fixed transaction costs, explaining the higher percentages of land set aside by

PES participants. Similar to Ortiz et al. (2003), farmers commonly cited three reasons for why they were already conserving: they were forced to do so by a federal deforestation ban; they were doing so for broader environmental reasons; or, the land was not economically useful (called “*montagne*” by farmers – mainly gullies, steep slopes and other areas unsuitable for agriculture). The son of a PES participant explained:

“My father started to create the farm and clear the natural areas, but left the centre of the farm forested because it is the source of several streams. My father now takes advantage of this incentive [PES].”

In short, it appears that some people are participating because they have large pieces of land that they cannot or choose not to farm, and that PES is not satisfying strict criteria for additionality. While there is notable regional variation (Arriagada et al., 2012; Daniels et al., 2010), multiple studies have reached the same conclusion (Morse et al., 2009; Ortiz Malavasi et al., 2003; Robalino and Pfaff, 2013; Robalino et al., 2008), and one might conclude that the Costa Rican PES is unsuccessful. However, because the Costa Rican PES program was not designed to work in isolation, but rather, was created as part of a multifaceted forest management strategy, it is meant in part to secure compliance with and support for the deforestation ban, not just act as a tool for generating additional conservation (Daniels et al., 2010; Legrand et al., 2013; Morse et al., 2009; Pagiola, 2008; Pfaff et al., 2008). As such, people affected by the ban are nevertheless allowed to apply for PES, even though they have to conserve their forest anyway, and additionality and avoided deforestation are incomplete measures of the program’s conservation impact (Daniels et al., 2010). Legrand et al (2013) conclude that an important contribution of Costa Rica’s PES is strengthening and generating support for forest conservation institutions.

Given that a majority of participants in our study are motivated at least in part by environmental values, and given at least some are doing something that they would do anyway, our study supports this conclusion.

Rather than implying that the Costa Rican program is less successful than one generating high levels of measured additional ES benefits, reinforcing and building environmental values and cultural practices and norms connected to conservation could be at least as valuable a conservation outcome, and focusing on this goal could help to address some common critiques of PES (Chan et al., 2017a). For example, focusing on supporting environmental values rather than additionality means that PES don't have to exclude those who are already conserving, reducing the potential for perverse incentives (e.g., cutting down a forest in order to qualify for reforestation PES) and lowering the risk that those excluded because they were already conserving might consequently reduce their conservation effort as a result of their exclusion (Alpizar et al., 2017).

Harnessing values could also provide better conservation value in the long term, for example through public support for concurrent policy instruments like deforestation bans and taxes earmarked for conservation (as seen in the Costa Rican program), by reducing monitoring costs (Chan et al., 2017a), and by using the PES program to secure additional external conservation funding (Legrand et al., 2013). PES can expand environmental awareness and extend perceptions of ecosystem value (Legrand et al., 2013); where this leads to cultural change, social incentives might then help to secure more widespread conservation behavior. This idea is supported by an experimental study that showed concern for reputation increased support for a recycling program

in Costa Rica (Alpizar and Gsottbauer, 2015), and conversely by the finding that deforestation raises the probability that neighbours will also deforest (Robalino and Pfaff, 2012). In a study of Costa Ricans living next to a national park, local people adopted the language of forest values used in the park's conservation programs, and large-scale land clearing came to be perceived as unacceptable (Schelhas and Pfeffer, 2005). Similarly, in some areas surveyed by Ortiz Malavasi et al. (2003), participants felt that PES was responsible for a cultural shift towards more sustainable practices, like protecting water courses. Because social incentives can secure greater effort than monetary incentives (Heyman and Ariely, 2004), changing norms could provide a greater conservation impact overall. Finally, fostering environmental values could also result in longer-term sustainability impacts, as people are more likely to continue conservation behaviours past the end of a program if they are brought on board to understand and support the program's values (Clements et al., 2010). To this end, a language of "stewardship" in PES has been suggested to help to cultivate the moral responsibility an ES provider feels towards ecosystems (Chan et al., 2017a; Solazzo et al., 2015), and more than one author has identified drawbacks to focusing on additionality as a measure of PES success (Chan et al., 2017a; Legrand et al., 2013).

Our results, together with past studies, give weight to the need for future research to explore how PES programs might be redesigned to support and harness non-material and value-based motivations. While we acknowledge that having more intangible conservation goals may make it more difficult to evaluate PES, in that it will be more difficult to rigorously set and measure criteria for success, we suggest that the potential for a values-oriented PES to secure sustained conservation and avoid common critiques, like high monitoring costs and exclusion of those already conserving, make it worth pursuing these questions as topics of future research.

4.4 Conclusion: New directions for PES?

We used survey and interview data from San Carlos, Costa Rica to explore who participates in PES and why, and how PES is correlated with wellbeing and farming practices. Looking at a broad array of wellbeing variables, we found PES participation to be linked to land and indicators of openness to novelty and learning. We found evidence that participants with different characteristics participate for different reasons, but almost all appear to be motivated to participate, at least in part, by intangible environmental motivations. Finally, we found evidence that while the Costa Rican PES program may not be incentivizing much additional conservation, it may be delivering some less tangible – but arguably very important - environmental benefits. Our findings raise questions about how we conceptualize, design, implement and measure in PES programs, and how PES might ultimately contribute to realizing conservation goals. Our reflections on these questions can be summarized into two main suggestions to guide future PES research. First, using research on agricultural innovation as a starting point, further research to understand the characteristics and motivations of different groups of potential PES participants, and the nature and role of “early adopters” of PES in particular, could improve program targeting and participation. Flexible program designs that allow participants to propose activities that have lower costs for them and/or that allow income generation, could not only increase the access to PES, they could also make transitioning to more sustainable farming practices more economically viable for producers while expanding the number of ES included in a PES program (and thereby reducing unintended spillover effects). Second, our findings lend support to ideas presented in Chan et al. (2017a) that it may be beneficial, and address some important challenges to PES uptake, to reimagine PES as a tool that harnesses values and rewards stewardship, while

decreasing emphasis on concepts like opportunity cost and additionality. Instead of goals of creating or conserving additional target ES and providing income for ES providers, such a program might instead aim to deliver intangible wellbeing benefits while supporting and propagating environmental values and cultural change, towards the generation of more intangible but potentially longer term, lower cost, and more equitable conservation benefits from PES.

Chapter 5: Participation in PES and dairy value chains and the use of sustainable farming practices in Costa Rica

5.1 Introduction

Agriculture is a key land use from the perspective of global sustainability. Based on data from the Food and Agriculture Organization (FAO), agricultural land uses are estimated to cover approximately 38% of global ice-free land area (Foley et al., 2011; Ramankutty et al., 2008). This land is divided among approximately 570 million farms (Lowder et al., 2016), of which approximately 98% are family farms (Graeub et al., 2016). To feed a growing human population, it is projected that agricultural production will need to increase by 50% globally between 2012-2050 (FAO, 2017a). At the same time, agriculture is a major polluter, contributor to global climate change and biodiversity loss, and consumer of resources (FAO, 2017a). Agriculture will need to become more sustainable to secure global sustainability (FAO, 2017a). To improve agricultural sustainability, it will be important to understand how different factors help or hinder the uptake of more sustainable agricultural practices by farmers.

Payments for ecosystem service (PES) programs have involved producers and agricultural land worldwide in the pursuit of environmental sustainability. In PES, governments and/or beneficiaries of ecosystem services (ES), the processes by which ecosystems provide benefits to people (Levine and Chan, 2011; MA, 2005), compensate ES providers. While occasionally, programs will incentivize farmers to use more sustainable farming practices, programs more commonly involve protection and reforestation activities.

In theory, PES could be associated with lesser—or greater—uptake of sustainable agricultural practices. On the lesser side, participation in environmental activities has led some people to feel justified in shirking other environmental responsibilities (Igoe, 2013). Conversely, environmental values appear to motivate participation in PES programs in some cases (Arriagada et al., 2015; Ortiz Malavasi et al., 2003), and participation in environmental programs has been found to create more positive perceptions of environmental practices among farmers (Fleury et al., 2015). However, most evaluations of the environmental implications of PES focus on the ES targeted by the program (usually 1-2 ES); considerably less attention has been given to how and whether PES participation is associated with differences in non-target ES and the practices that support these ES.

Markets for farm products can also influence the sustainability of agricultural practices in positive and negative ways. Increasingly, producers are engaging in modernized food value chains, characterized by vertical coordination and spatial separation between producers and consumers (Barrett et al., 2012; 2001; Reardon and Barrett, 2000). Intermediary firms can exercise considerable power in these value chains, including influencing agricultural practices. Studies have found increased use of chemical inputs in modernized value chains and contract farming arrangements (Barrett et al., 2001; Ruben and Sáenz, 2008), and constraints on producer choices with respect to land management (Stuart, 2008).

At the same time, firms are playing a growing role in environmental governance via mechanisms that include formal standards and corporate social responsibility (CSR) (Dauvergne and Lister, 2011; Fuchs and Kalfagianni, 2017; Kalfagianni, 2013), meaning firms are also in a position to

influence agricultural sustainability. CSR involves a firm's responsibility for its societal impact (European Commission, 2018), and includes a broad range of voluntary actions aimed at integrating social, human rights, environmental and ethical concerns into business practices and relationships (Fuchs et al., 2011; Gereffi and J. Lee, 2015; Hartmann, 2011; Newell and Frynas, 2007). CSR activities can operate inside or alongside the value chain (e.g., implementing a program to reduce electricity consumption in a production facility, versus a habitat protection program facilitated by the firm), with presumably different implications for value chain actors. In theory, a firm's CSR activities in a food value chain could increase the sustainability of farming practices via initiatives involving the producers supplying a given value chain (e.g., implementing standards that regulate the types and amounts of inputs used, or implementing a CSR activity that supported producers supplying the value chain to plant stream buffers). Sustainability initiatives by private firms have been both criticized as "green washing" and described as (sometimes insufficient) contributors to global sustainability (Dauvergne and Lister, 2011; Fuchs and Kalfagianni, 2017; 2009; Newell and Frynas, 2007). Generally, firms define the criteria by which the success of their own CSR and standards are measured, such that it is not always clear what contribution these initiatives are making to sustainability overall (Fuchs et al., 2011; Fuchs and Kalfagianni, 2017). It has been argued that the influence of value chain actors on farmers needs to be included to understand farmer uptake of sustainable farming practices (Stuart, 2008). Yet the literature on the adoption of sustainable agricultural practices tends not to give much attention to value chain influences on adoption (e.g., conservation agriculture (Andersson and D'Souza, 2014; Arslan et al., 2014)).

Thus, participation in both PES programs and modern value chains can likely influence the sustainability of agricultural practices in positive and negative ways, yet little attention has been paid in either the PES or market participation literature to the implications of these opportunities for agricultural practices. To address these gaps, this study explored the relationships between farming practices and participation in PES and in modernized value chains in a case study of dairy farmers in Costa Rica. We expect that looking at these two influences on farming practices in parallel could provide novel insight, given evidence that livelihood activities can influence farmer perceptions of and engagement with nature (Kross et al., 2017), and that value chains can have a significant influence on farming practices (Stuart, 2008). Using surveys and interviews with statistical and qualitative analyses, we explored the farming practices of PES participants versus non-participants, and of participants in modernized dairy value chains versus traditional dairy value chains.

5.2 Methods

5.2.1 Case study: San Carlos, Costa Rica

This study was conducted with cattle farmers in San Carlos, Costa Rica. Data was collected via household surveys and interviews. Survey respondents included PES participants and non-participants, and households selling into traditional and modernized dairy value chains (Table 5.1). Due to errors in the data used to construct our sample, ten non-dairy cattle farming households were surveyed to boost the number of PES participants in the sample (please see Chapters 1 and 4 for more details). Non-dairy survey respondents were not included in comparisons of modern dairy value chain participants to traditional value chain participants and

were controlled for in regressions of PES with farming practices. Semi-structured interviews were conducted with key informants in the dairy and PES sectors.

Table 5.1 Survey participant characteristics: PES and dairy market participation

	PES participant	Not PES participant	
Modern dairy value chain	23	116	140
Traditional dairy value chain	7	60	67
Non-dairy cattle value chain	7	3	10
	37	180	

Chapters 1 and 2 of this dissertation provide additional details about the study area, participants, dairy value chains in San Carlos, sampling and data collection methods. Chapter 4 of this dissertation provides additional details about PES in Costa Rica.

For this study, producers selling via the Coopebrisas dairy cooperative are counted as modernized market farmers. The Coopebrisas value chain shares characteristics with both modern and traditional value chains in San Carlos. Like other local and regional scale processors in traditional value chains, Coopebrisas sources from local producers (its cooperative members), produces dairy products, and sells them to regional retailers. Coopebrisas does not have the large geographic separation between producers and consumers characteristic of modernized value chains. However, being a cooperative, Coopebrisas is more vertically coordinated than other value chains involving regional processors and has strict quality standards like modernized value chains. It also engages in considerably more marketing and branding of its products, like the modernized dairy value chains. Because this analysis focuses on farmer practices in the context

of agricultural sustainability, we count Coopebrisas with the other modernized value chains operating in San Carlos. Like Dos Pinos, Sigma Alimentos, and Florida Ice & Farm Co. (whose dairy division, Florida Lácteos, is supplied by the Coopeleche cooperative), Coopebrisas has made a public commitment to environmental sustainability on its website (Dos Pinos, 2017; Coopebrisas, 2018; FIFCO, 2015; Sigma, 2018).

5.2.2 Study variables and analysis

In this study, we sought to understand whether and how farming practices vary with producer participation in PES, and with producer participation in a modern value chain. We looked at three categories of farming practices: input use, environmental farm management practices (practices used directly in the course of cattle farming activities and/or to manage land on which farm activities occur), and conservation practices (occurring on land physically separate from farming activities) (Table 5.2).

Table 5.2 Farming practice study variables

INPUTS:	ENVIRONMENTAL MANAGEMENT PRACTICES:	CONSERVATION:
<ul style="list-style-type: none">• Herbicide use• Insecticide use• Chemical fertilizer use• Hormone use	<ul style="list-style-type: none">• Active watercourse protection (e.g. via buffers, excluding cattle from streams, etc.)• Management of milk shed waste (Composting, biodigestion)• Agroforestry practices (trees planted in fields, living fences)	<ul style="list-style-type: none">• Land set aside for conservation

The agricultural practices included in this study are drawn from sustainable agriculture concepts. There are multiple conceptualizations of sustainable agriculture in the literature; however, some common ideas can be found across concepts (Koohafkan et al., 2012). Common principles include reducing or eliminating chemical inputs, minimizing GHG emissions and promoting carbon sequestration, protecting water and soil from pollution, reducing losses of habitat and biodiversity, maintaining soil organic matter and biodiversity, and using water sustainably (CGSB, 2015; Koohafkan et al., 2012; Kremen et al., 2012; Sandhu et al., 2010). Thus, we included several common inputs in dairy farming in Costa Rica: chemical insecticides, herbicides and fertilizers, and hormones (given to cattle). Hormones are included because they are generally not permitted in organic agriculture (CGSB, 2015), understood to include many sustainable farming practices and be part of a movement towards a more sustainable food system (Sandhu et al., 2010; Seufert and Ramankutty, 2017). Hormones can persist in waterways and

interrupt the endocrine processes of fish and other animals (Gavrilescu et al., 2015; Li, 2014; Richardson and Kimura, 2015).

We also included several environmental farm management practices that reflect sustainable agriculture concepts: actively protecting water courses (e.g. via vegetation buffers, or restricting cattle from entering streams), agroforestry practices, managing milk shed waste, and setting land aside for conservation. Managing milk shed waste and protecting water courses can reduce water pollution (Carpenter et al., 1998; Schoumans et al., 2014). Agroforestry practices can sequester carbon (Albrecht and Kandji, 2003) and contribute to the functional diversity of farming systems (Kremen et al., 2012). Conservation land can protect habitat and biodiversity.

Apart from combined variables, all agricultural practice variables for this analysis were binary. To explore relationships with different categories of farm practices (Input Use, Environmental Management Practices, Conservation), we created two summed “combined” variables for inputs and environmental management practices. Conservation is not included in combined environmental practices because it generally happens on farm land separate from active agricultural use, whereas the other practices usually happen on land that is being actively used for agricultural activities. We acknowledge that binary variables are not ideal, given that the literature on sustainable agriculture commonly talks about “reducing” rather than “eliminating” chemical inputs (e.g., Tscharntke et al., 2012). Our survey attempted to ascertain the intensity of use of different practices (e.g., for inputs like herbicides, we asked about the percent of the farm on which herbicides were applied, frequency of application, products used, and application rate).

However, we found that farmer recall for these variables was not consistent enough to use this data with confidence.

Statistical analysis of survey data was performed using R software. To understand if the use of different farming practices varied with PES participation, we compared the proportion using each practice for PES participants versus non-participants using proportion tests, and substituting a Fisher test where any cell count was less than ten. For combined variables, we compared PES participants to non-participants using Wilcoxon tests. We adjusted p-values using the Benjamini Hochberg method to control False Discovery Rate across multiple tests (Benjamini and Hochberg, 2000; 1995; Krzywinski and Altman, 2014).

Then, to control for other variables that we expect might also affect the use of certain farming practices, we further explored the relationships between PES participation and farming practices using regression. We ran several logistic regressions each with PES participation as the independent variable and different farming practice variables as dependent variables. For binary dependent variables, we used binary logistic models; for combined variables (count variables), we used Poisson logistic models.

Based on literature pertaining to adoption of agricultural technology and novel agricultural practices, we considered inclusion of several controls: wealth (indicated by an asset-based Wealth Index – please see Chapters 1 and 4 for details), education of the household head, number of information sources consulted for farm management, and organization membership. We expect that wealth may correlate positively to using farming practices that require input

purchases, additional labour or technology investments, or that have no or delayed financial returns to the farmer (Bell et al., 2016; Corbeels et al., 2014; Lambrecht et al., 2014; Pannell et al., 2006). Post-secondary education (Brown et al., 2016; Brown and Roper, 2017), access to information (Lambrecht et al., 2014), sex (Brown et al., 2016) and social capital (Abebaw and Haile, 2013; Hermans et al., 2013) have been connected to higher rates of adoption of agricultural technologies. Similarly, the adoption of new practices, including sustainable farming practices, has been linked with knowledge and information (Meijer et al., 2014), post-secondary education (Brown et al., 2016; Brown and Roper, 2017), sex (Brown et al., 2016), and collective action (Bravo-Monroy et al., 2016; Brown and Roper, 2017; Parsa et al., 2014). We included the highest education completed by the household head as a categorical variable with levels “Informal”, “Primary”, “Secondary”, “Post-Secondary”. “Informal” was treated as the base case.

In regressions of PES with farming practices, social capital is represented by cooperative membership, which indicates that households are part of formal social networks in their communities. In regressions of modern market participation with farming practices, social capital is indicated by household participation in organizations because cooperative membership was found to be too closely correlated to market participation, causing the regression equations to have high multicollinearity as a result. Experience is indicated by years cattle farming, and age of the household head. In PES regressions (where our sample included a small number of non-dairy cattle farmers to boost our sample of PES participants), we controlled for differences in production requirements between dairy and non-dairy farmers by including a binary “nondairy” variable. Multiple possible controls were considered in each model, as there has been found to be considerable variation in the factors associated with the uptake of agricultural practices in

different contexts (Knowler and Bradshaw, 2007; Schaible et al., 2015). A “best fit” model was chosen by comparing Akaike Information Criteria (AIC) using delta AIC (Akaike, 1992; 1981).

To examine relationships between farming practices and selling in a modern value chain that includes a stated public commitment to environmental sustainability (i.e. all vertically modernized value chains, including the Coopebrisas value chain), we then repeated the above procedures, substituting participation in a modern value chain for participation in PES. We included PES participation as a control in our regression to predict conservation, as conservation is by far the dominant PES modality incentivized by the national PES program in San Carlos.

Statistical analysis allowed us to identify significant correlations between participation in modern value chains or PES and farming practices. To build hypotheses about the nature and reasons for these relationships, we triangulated statistical results with qualitative analyses from this case study and insights from the literature. Qualitative data was collected from multiple meetings with key informants in the agricultural and PES sectors Costa Rica, exploratory focus groups and interviews with producers, and 20 semi-structured interviews.

5.3 Results

5.3.1 Two-way comparisons

We first compared the farming practices of PES participants to non-participants using descriptive statistical comparisons. We found no significant differences in the use of inputs or environmental farming practices (Figures 5.1 and 5.2). Participation in conservation appears more likely for

those participating in PES (Figure 5.2), which was expected given that “Protection” was the most common PES modality for study participants.

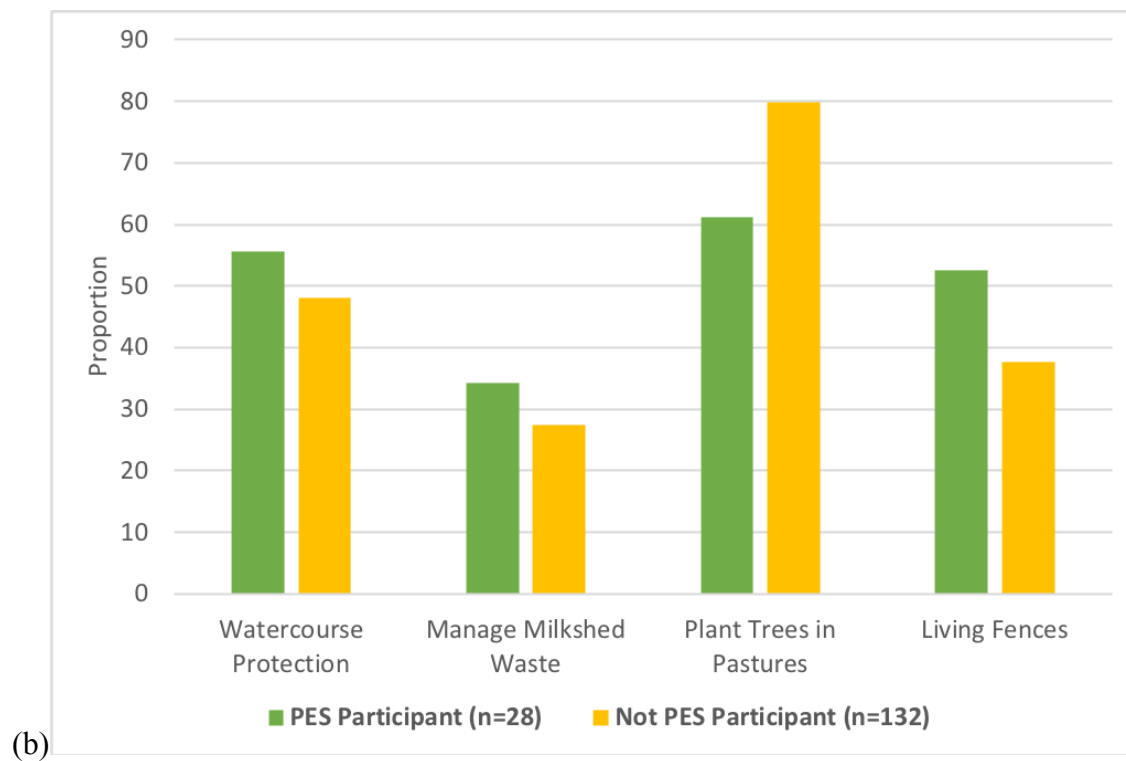
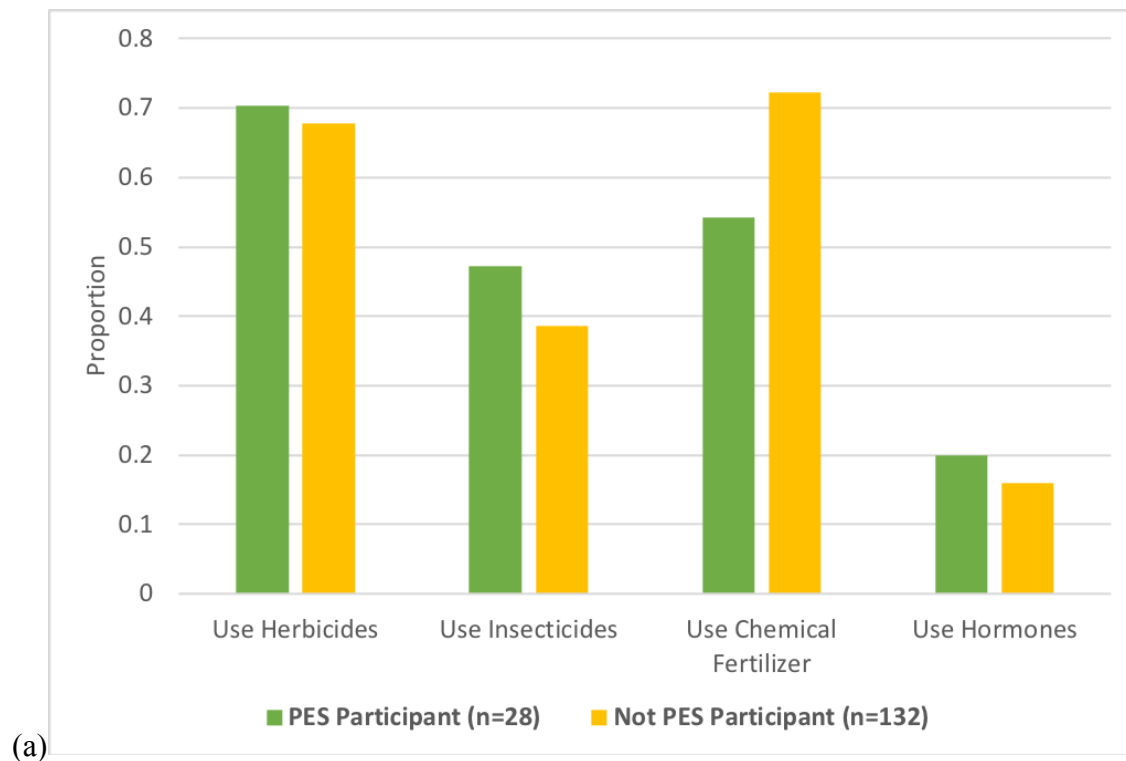


Figure 5.1 (a) Inputs and (b) environmental farm management practices used by PES participants versus non-participants. No significant differences were found.

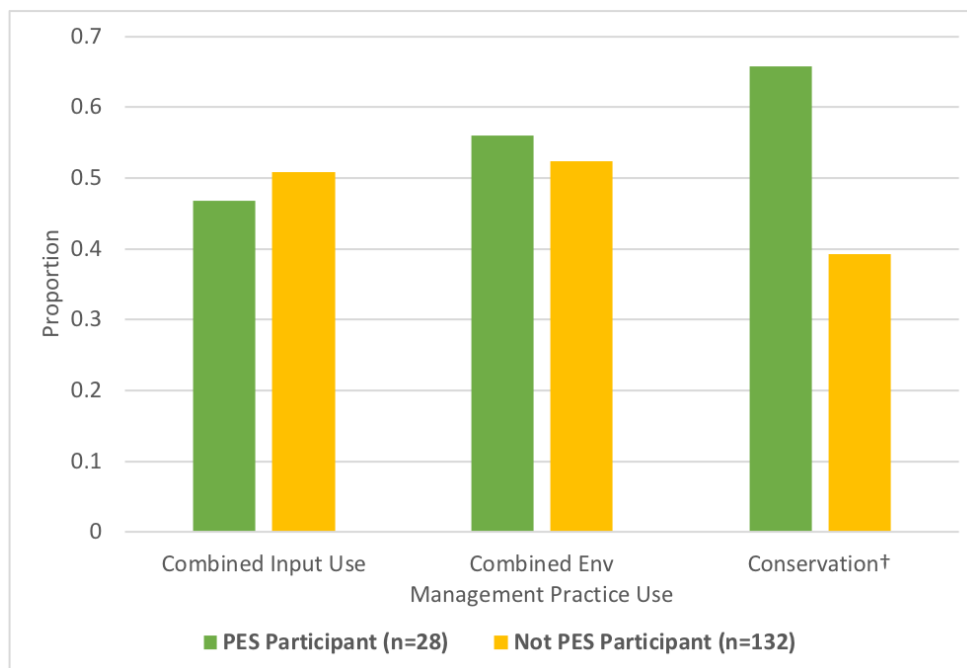


Figure 5.2 Combined input use, combined environmental farm management practice use, and conservation practiced by PES participants versus non-participants. Significant differences, after Benjamini-Hochberg adjustment, are indicated in x-axis († $p < 0.1$).

Comparing farming practices between farmers selling into modern versus traditional dairy markets (Figure 5.3) suggests that modern value chain farmers are more likely to use chemical inputs, and there is no significant difference in the use of other environmental management practices. Overall, combined indicators of input use and environmental management practices suggest modern market farmers likely use more types of chemical inputs, while there is no significant difference in the use of environmental management practices, including setting land aside for conservation (Figure 5.4).

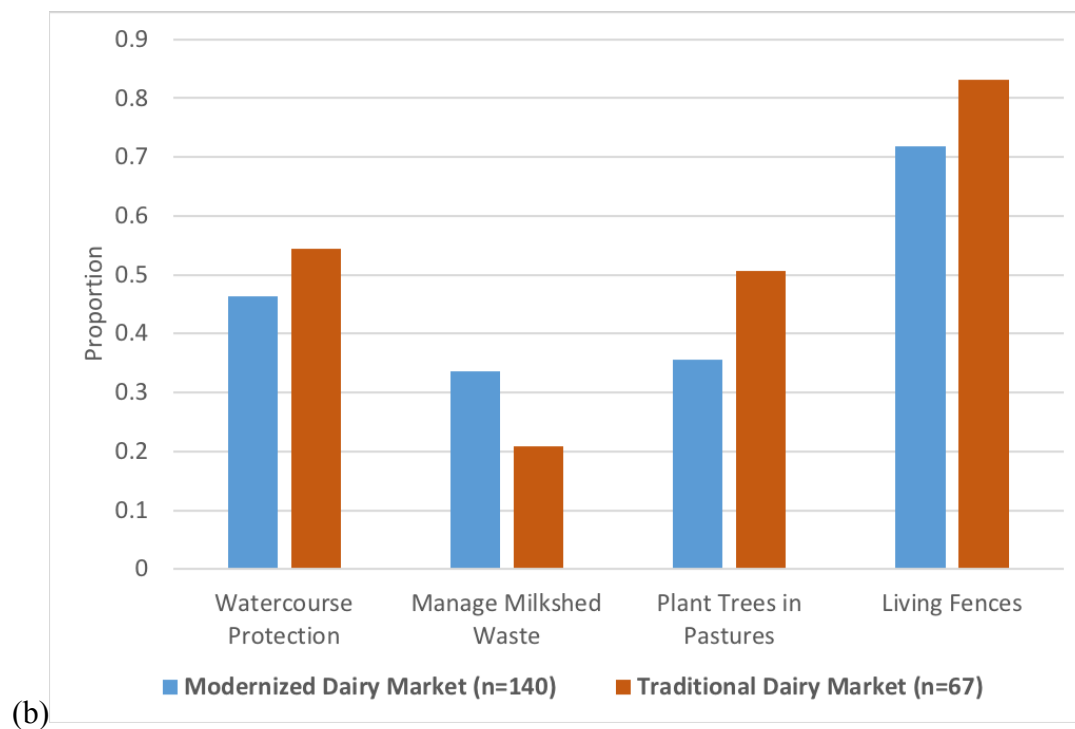
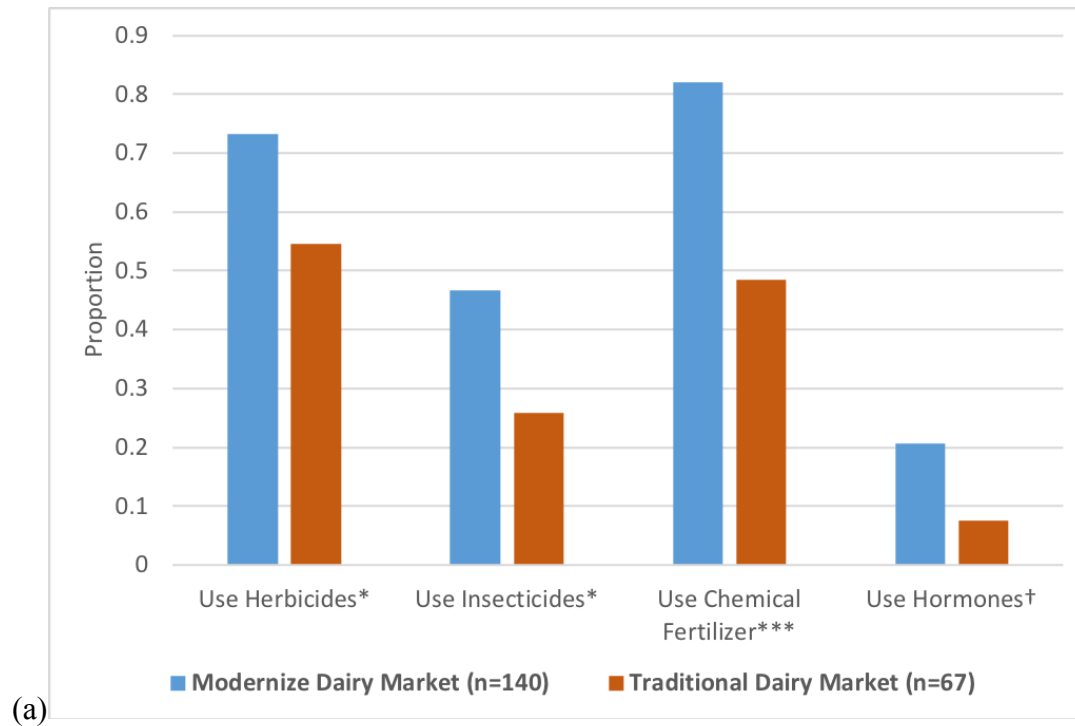


Figure 5.3 (a) Inputs and (b) environmental farm management practices used by farmers selling in modernized dairy markets versus traditional dairy markets. No significant differences were found.

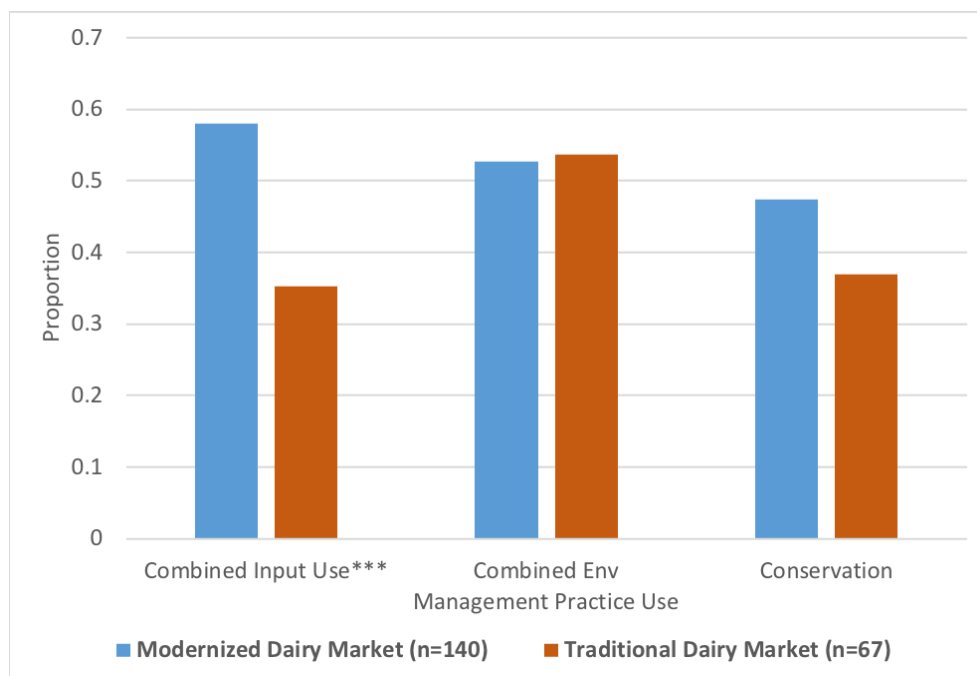


Figure 5.4 Combined input use, combined environmental farm management practice use, and conservation practiced by farmers selling in modernized versus traditional dairy markets. Significant differences, after Benjamini-Hochberg adjustment, are indicated in x-axes (***) $p < 0.001$.

While these figures provide an interesting visual picture of the relationships between farming practices and market participation and PES participation, they simplify what we expect are more complex relationships. Regressions provide a more nuanced understanding.

5.3.2 Regressions

Regressions suggest that, controlling for other factors, PES participation in San Carlos is not strongly linked to either input use or the use of more sustainable farm management practices, including setting land aside for conservation (Tables 5.3 and 5.4). PES has a stronger, though still non-significant, relationship to conservation, the most widely-used PES modality in our study.

In the PES regressions, wealth is a significant positive predictor of the use of all inputs, with the strongest effect sizes for use of chemical fertilizers and hormones (Table 5.3). Membership in a producer cooperative is a significant positive predictor of input use for all inputs except herbicides. Cooperative membership has the strongest effect on insecticide and hormone use, increasing the odds of using these inputs by 4.3 and 3.9 times respectively. Note that cooperative membership is strongly correlated to participation in modernized markets. Overall, we did not find a significant relationship between PES participation and combined input use, controlling for wealth, cooperative membership, number of information sources consulted for farm management, and farm type (dairy versus meat cattle farm).

Table 5.3 Results of regressions explaining use of various inputs (columns) via PES participation, controlling for factors expected to affect agricultural technology adoption. After removal of cases with missing data, n = 160. A variable with an odds ratio below 1 means that the variable is associated with decreased likelihood of using the input; an odds ratio above 1 means the variable is associated with increased likelihood of using the input.

Independent variable (PES participation) & Controls	Dependent variable – Input Use				
	Herbicide Use	Insecticide Use	Chemical Fertilizer Use	Hormone Use	Combined Input Use
	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)	Odds ratio (95% CI)
PES participation	0.84 (0.30, 2.53)	1.8 (0.62, 5.6)	0.44 (0.14, 1.5)	1.3 (0.34, 4.1)	0.95 (0.68, 2.3)
Wealth Index	1.6* (1.1, 2.6)	1.7* (1.0, 2.8)	2.6*** (1.6, 4.7)	2.2* (1.1, 4.6)	1.2** (1.1, 1.4)
Years cattle farming	0.98 (0.95, 1.0)	-	-	-	-
Age of household head	1.0 (1.0, 1.1)	-	-	-	-
Sex of household head	-	0.16* (0.026, 5.6)	-	-	-

Independent variable (PES participation) & Controls	Dependent variable – Input Use				
	Herbicide Use Odds ratio (95% CI)	Insecticide Use Odds ratio (95% CI)	Chemical Fertilizer Use Odds ratio (95% CI)	Hormone Use Odds ratio (95% CI)	Combined Input Use Odds ratio (95% CI)
Number of info sources consulted for farm management	-	0.39** (0.20, 0.69)	-	0.41* (0.17, 0.85)	0.85† (0.72, 1.0)
Membership in producer cooperative	1.4 (0.68, 3.0)	4.3** (1.7, 11.5)	2.9* (1.1, 7.8)	3.9* (1.2, 15.8)	1.4* (1.1, 1.9)
Non-dairy cattle farmer	1.2 x 10 ⁷ (1.14 x 10 ⁻⁵² , NA)	1.4 (0.12, 14.6)	0.51 (0.024, 4.7)	3.9 (0.15, 49.3)	1.3 (0.59, 2.7)
Highest level of education completed by household head					
- Primary	-	1.2 (0.50, 3.1)	0.51 (0.16, 1.5)	-	-
- Secondary	-	0.49 (0.14, 1.6)	0.20* (0.045, 0.80)	-	-
- -Post-secondary	-	0.074* (0.0073, 0.45)	1.3 (0.13, 30.1)	-	-
Cox Snell Pseudo R ²	0.0875	0.181	0.233	0.102	0.135
Model p-value	0.0232	2.06 x 10 ⁻⁴	4.12 x 10 ⁻⁷	0.00402	0.000310

† p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001

Similarly, in regressions of PES with all environmental farm management practices except agroforestry, we found having greater wealth significantly increased the odds of using these practices (Table 5.4). This was also true of conservation. Wealth had the strongest effect on watercourse protection, milk shed waste management, and conservation. The model predicting

combined environmental practice use was insignificant. Being in a cooperative decreased the odds of engaging in watercourse protection and planting trees in pastures, controlling for wealth; again, it is notable that cooperative membership is highly correlated with modern value chain participation. Overall, we found no significant relationship between PES participation and combined environmental farm practice use (excluding conservation). Higher wealth significantly increased the odds of participating in environmental practices overall as indicated by the combined variable, but only by a small amount.

Table 5.4 Results of regressions of environmental farm management practices with PES participation, controlling for factors expected to affect agricultural technology adoption. After removal of cases with missing data, n = 160. A variable with an odds ratio below 1 means that the variable is associated with decreased likelihood of using the practice; an odds ratio above 1 means the variable is associated with increased likelihood of using the practice.

Independent variable (PES participation) & Controls	Dependent variable – Environmental Farm Practice				
	Watercourse Protection Odds ratio (95% CI)	Manage Milk Shed Waste Odds ratio (95% CI)	Plant Trees in Pastures Odds ratio (95% CI)	Use Living Fences Odds ratio (95% CI)	Set Aside Land for Conservation Odds ratio (95% CI)
PES participation	0.78 (0.30, 2.0)	1.1 (0.35, 3.1)	0.18 (0.66, 4.9)	0.37 [†] (0.13, 1.1)	2.5 [†] (0.93, 1.6)
Wealth Index	1.8** (1.2, 2.9)	1.8* (1.1, 3.1)	1.4 (0.91, 2.3)	1.2 (0.77, 1.8)	1.7* (1.2, 2.7)
Years cattle farming	-	1.0 [†] (1.0, 1.1)	-	0.98 (0.96, 1.0)	-
Age of household head	-	-	-	-	-
Sex of household head	3.5 (0.73, 25.5)	-	-	-	-
Number of info sources consulted for farm management	-	-	-	-	-
Membership in producer cooperative	0.44* (0.20, 0.95)	-	0.21*** (0.085, 0.49)	-	-

Independent variable (PES participation) & Controls	Dependent variable – Environmental Farm Practice				
	Watercourse Protection Odds ratio (95% CI)	Manage Milk Shed Waste Odds ratio (95% CI)	Plant Trees in Pastures Odds ratio (95% CI)	Use Living Fences Odds ratio (95% CI)	Set Aside Land for Conservation Odds ratio (95% CI)
Non-dairy cattle farmer	1.4 (0.14, 14.2)	2.4×10^{-7} (NA, 4.4×10^{47})	3.5×10^{-8} (NA, 2.0×10^{46})	6.7×10^6 (6.8×10^{-51} , NA)	0.41 (0.015, 4.6)
Highest level of education completed by household head					
- Primary	-	0.74 (0.28, 2.1)	0.64 (0.26, 1.6)	-	0.56 (0.24, 1.3)
- Secondary	-	2.2 (0.69, 7.3)	1.9 (0.62, 5.9)	-	1.4 (0.48, 4.4)
- -Post-secondary	-	1.3 (0.28, 5.5)	1.2 (0.28, 4.7)	-	0.91 (0.22, 3.7)
Cox Snell Pseudo R ²	0.0699	0.133	0.129	0.0583	0.124
Model p-value	0.0408	0.00189	0.00249	0.0475	0.0176

† p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001

Regressions of farming practices with participation in a modernized dairy value chain contrasted with those with PES participation. We found participation in a modernized dairy value chain to be a significant positive predictor of input use for all inputs except herbicides (Table 5.5). The strongest effect was on hormone use, with modern value chain participation increasing the odds of using hormones 5.6 times. Household participation in organizations also had a large, significant positive effect on the odds of using hormones. Wealth is also an important positive predictor of the use of most inputs, although effect sizes are smaller than those for modernized market participation.

Table 5.5 Results of regressions of input use with participation in a modernized dairy value chain (MVC), controlling for factors expected to affect agricultural technology adoption. After removal of cases with missing data, n = 160. A variable with an odds ratio below 1 means that the variable is associated with decreased likelihood of using the input; an odds ratio above 1 means the variable is associated with increased likelihood of using the input.

Independent variable (Modernized value chain (MVC) participation) & Controls	Dependent variable – Input Use				
	Herbicide Use Odds ratio (95% CI)	Insecticide Use Odds ratio (95% CI)	Chemical Fertilizer Use Odds ratio (95% CI)	Hormone Use Odds ratio (95% CI)	Combined Input Use Odds ratio (95% CI)
MVC participation	1.5 (0.64, 3.4)	3.1* (1.3, 8.2)	3.1* (1.2, 7.9)	5.6* (1.3, 33)	1.5** (1.1, 2.1)
Wealth Index	1.5 [†] (0.97, 2.3)	1.6 [†] (1.0, 2.7)	2.4** (1.4, 4.3)	3.1** (1.5, 7.3)	1.2* (1.0, 1.4)
Years cattle farming	0.98 (0.95, 1.0)	-	-	-	-
Age of household head	1.0. (1.0, 1.1)	-	-	0.96 [†] (0.92, 1.0)	-
Sex of household head	-	-	-	0.13 [†] (0.012, 1.4)	-
Number of info sources consulted for farm management	-	0.50* (0.28, 0.85)	-	0.41* (0.17, 0.86)	0.84* (0.71, 0.99)
Household participates in organizations	-	-	-	3.8* (1.3, 12)	-
Highest level of education completed by household head					
- Primary	-	1.2 (0.52, 3.0)	0.59 (0.19, 1.6)	0.36 (0.097, 1.3)	-
- Secondary	-	0.51 (0.15, 1.6)	0.27 [†] (0.065, 1.0)	0.26 (0.047, 1.3)	-
- Post-secondary	-	0.14* (0.018, 0.69)	1.7 (0.19, 40.1)	0.17 [†] (0.017, 1.2)	-
Cox Snell Pseudo R ²	0.0695	0.147	0.216	0.147	0.146
Model p-value	0.0212	0.000293	2.52 x 10 ⁻⁷	0.00243	1.42 x 10 ⁻⁵

[†] p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001

Participation in modernized dairy value chains was a less important predictor of environmental farm management practices (Table 5.6). Modernized market participation had either no effect or a negative relationship with the use of most practices. The relationship was significant for watercourse protection and planting trees in pastures. Wealth significantly increased the odds of using almost all environmental practices, except agroforestry practices. The model predicting living fences was insignificant. Overall, modernized value chain participation had an insignificant negative relationship to combined environmental management practice use. Wealth was a significant predictor of combined environmental practice use, but only moderately increased the odds of using these practices. Similarly, increased wealth also significantly raised the odds of engaging in conservation, but with only a moderate effect size. Modernized market participation had a non-significant negative relationship with conservation, controlling for wealth, number of information sources, and PES participation.

Table 5.6 Results of regressions of environmental farm management practices with participation in a modernized dairy value chain (MVC), controlling for factors expected to affect adoption of novel agricultural practices. After removal of cases with missing data, n = 160. A variable with an odds ratio below 1 means that the variable is associated with decreased likelihood of using the input; an odds ratio above 1 means the variable is associated with increased likelihood of using the input.

Independent variable (modernized value chain (MVC) participation) & Controls	Dependent variable – Environmental Farm Practices				
	Watercourse Protection Odds ratio (95% CI)	Manage Milk Shed Waste Odds ratio (95% CI)	Plant Trees in Pastures Odds ratio (95% CI)	Combined Management Practices Odds ratio (95% CI)	Set Aside Land for Conservation Odds ratio (95% CI)
MVC participation	0.39* (0.16, 0.89)	1.0 (0.41, 2.7)	0.31** (0.13, 0.71)	0.81 (0.60, 1.1)	0.71 (0.29, 1.7)
Wealth Index	2.0** (1.3, 3.2)	2.0** (1.2, 3.4)	1.5 [†] (0.98, 2.3)	1.2** (1.1, 1.5)	1.8** (1.2, 3.0)

	Dependent variable – Environmental Farm Practices				
Independent variable (modernized value chain (MVC) participation) & Controls	Watercourse Protection Odds ratio (95% CI)	Manage Milk Shed Waste Odds ratio (95% CI)	Plant Trees in Pastures Odds ratio (95% CI)	Combined Management Practices Odds ratio (95% CI)	Set Aside Land for Conservation Odds ratio (95% CI)
Years cattle farming	-	1.0* (1.0, 1.1)	-	-	-
Age of household head	-	-	-	-	-
Sex of household head	-	-	-	-	-
Number of info sources consulted for farm management	-	-	-	-	1.4 (0.88, 2.3)
Household participates in organization(s)	-	-	1.9 [†] (0.91, 3.9)	-	-
Highest level of education completed by household head					
- Primary	-	-	-	-	-
- Secondary	-	-	-	-	-
- -Post-secondary	-	-	-	-	-
PES participation	NA	NA	NA	NA	2.3 (0.85, 6.6)
Cox Snell Pseudo R ²	0.0682	0.0961	0.066	0.0453	0.104
Model p-value	0.00350	0.00105	0.012	0.0246	0.00148

[†] p < 0.1 * p < 0.05 ** p < 0.01 *** p < 0.001

For both modernized market participation and PES, the number of information sources consulted to inform farm management had a negative relationship with the use of several inputs. Similarly, where higher education had a significant effect on environmental practice use, the relationship was negative. For all regressions, control variables other than wealth and cooperative

membership tended to have very small effect sizes. Some insignificant control variables were included because they improved model fit.

5.3.3 Farm management considerations and goals

We asked participants open-ended survey questions about the factors they take into consideration when managing their farms and their goals for farm management (Figures 5.5 and 5.6). Although the open-ended nature of these questions resulted in response rates that were too low to compare groups statistically, some striking patterns are apparent. While environmental considerations and goals do appear to be more important to PES participants relative to non-participants, as one might expect, they are notably less prominent than many other farm management goals and considerations. An exception is the farm management goals of dairy farmers in traditional dairy markets, where environmental goals were identified more often than other goals by that group. By contrast, modernized market farmers appear to be more strongly focused on the economic goal of efficiency.

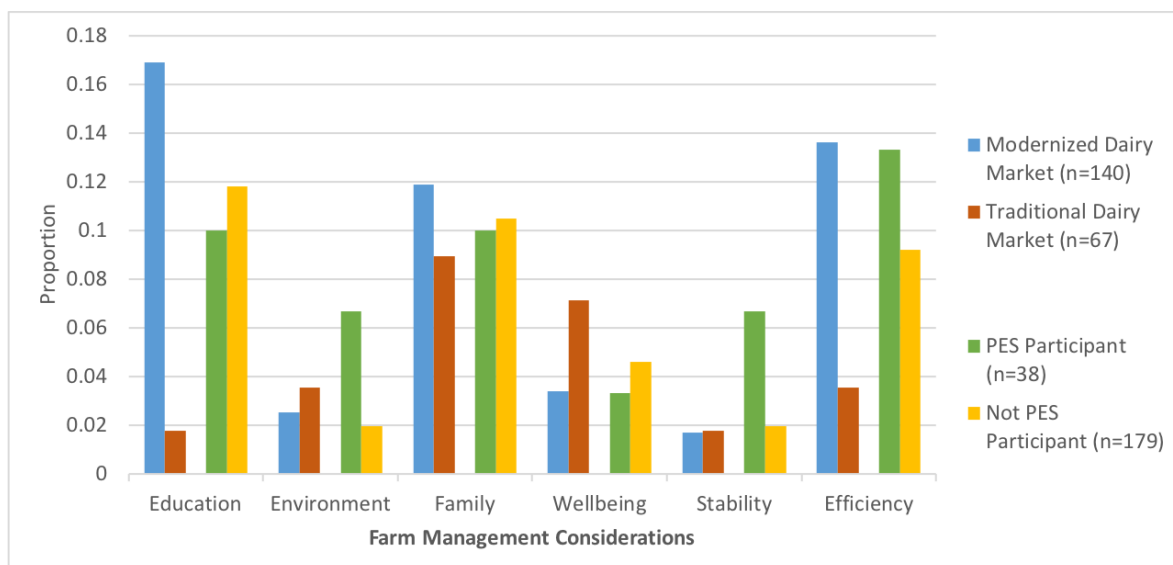


Figure 5.5 Proportion of participants identifying different considerations as important factors in their farm management decisions. Question was open-ended and participants could identify multiple considerations. Some participants declined to answer. Only considerations identified by more than one participant are included. Statistical comparisons were not made for this data due to low n.

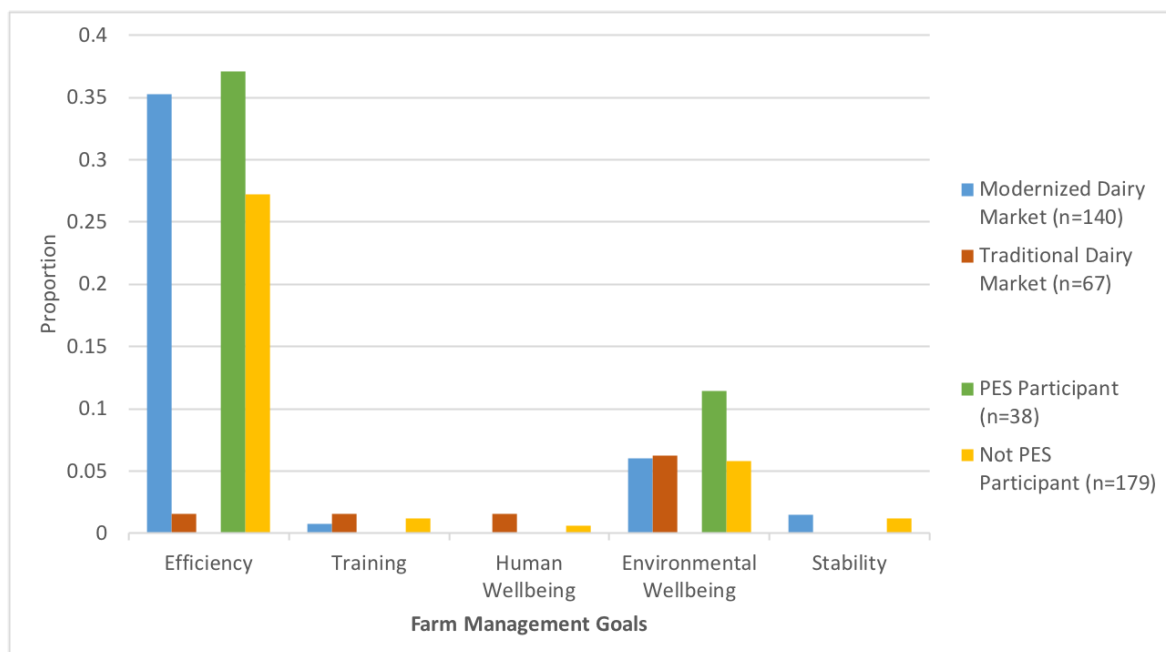


Figure 5.6 Proportion of participants identifying different farm management goals. Question was open-ended and participants could identify multiple goals. Some participants declined to answer. Only goals identified by more than one participant are included here. Statistical comparisons were not made for this data due to low n.

5.4 Discussion and conclusions

5.4.1 Predicting the adoption of sustainable farming practices

The regressions presented some interesting results in relation to control variables expected to be potential predictors of environmental farming practice uptake based on the agricultural adoption literature. For regressions of farming practices with PES and with modern value chain participation, consulting more information sources to inform farm management decreased the odds of using certain inputs. Similarly, having higher education decreased the odds of using some inputs. This is interesting, given that information and higher education have been found to be positively related to the adoption of inputs, practices, and technologies (Brown et al., 2016; Lambrecht et al., 2014). We hypothesize that in the case of dairy in San Carlos, use of chemical inputs may be the status quo, particularly in modernized markets. As such, using alternatives to chemical inputs while still meeting the production and quality requirements of a given dairy market would be novel practices by comparison, such that, a negative relationship between input use and information and higher education would be in line with predictions of the agricultural adoption literature. In short, more information and education may help farmers to meet their market requirements without the use of chemical inputs. Further research would be required to confirm this hypothesis.

The agricultural adoption and innovation literature also suggests how regression models in this study might be improved. Although all but two of our regression models were significant, pseudo R^2 values were low for most models, particularly for regressions predicting environmental farm management practices. Based on the agricultural adoption literature, we suspect that our models might be improved by including indicators of farmer attitudes towards learning, novelty, and risk

(Abadi Ghadim and Pannell, 1999; Alpízar et al., 2011; Brown and Roper, 2017; Dunn et al., 2016), and farmer perceptions of the farming practices in this study and of the benefits and costs of their adoption (Meijer et al., 2014; Pannell et al., 2006; 2014).

This hypothesis is supported by comparing regressions of PES and participation in conservation between Chapter 4 of this dissertation and this analysis. In Chapter 4, we took a more exploratory approach to regression model building and found PES to be a significant predictor of conservation. Taking a more theoretical approach to model building above, we did not find a significant relationship between conservation and PES participation. We hypothesize that these differences may be due, in part, to the regression model in Chapter 4 including some variables, like email use and number of household income sources, that we hypothesize could be linked to factors like farmer attitudes to innovation, which have been associated with agricultural practice uptake (Brown and Roper, 2017). In Costa Rica in particular, farmers in the coffee sector have been found to be highly risk averse (Alpízar et al., 2011), suggesting that perceptions of risk might also be important in this case. In this analysis, we did not include these variables as controls because they had not been tested in the agricultural adoption literature as indicators of attitudes towards innovation. Further research would be needed to confirm if our hypothesis is correct.

5.4.2 PES participation, values, and incentives versus constraints

This study highlights that values do not always correspond to actions, a potentially important consideration in environmental incentive programs like PES. In San Carlos, environmental motivations appear important to PES participation (Chapter 4), and this analysis suggests that

PES participants may be more likely to take environmental considerations into account in their farm management relative to non-participants. Yet, regressions in this study suggest that PES participation does not correlate to the use of more sustainable agricultural practices. This suggests that constraints may be preventing some farmers from using agricultural practices that align with their environmental values. Given the predictive importance of cooperative membership (strongly correlated with modernized dairy market participation) in regressions of PES with farming practices, we hypothesize that modern market constraints, like quantity and quality requirements, may be dominating farm management choices.

This hypothesis is supported by qualitative interviews conducted in this study, in which producers and dairy sector key informants repeatedly described increasing competition and decreasing margins in modern dairy markets, and mounting pressure on producers to increase their efficiency in response. This reflects findings that farmers may not adopt a practice if they perceive it will complicate farm management and/or affect profitability (Dunn et al., 2016). Further, a study in California found that farmers were engaging in practices stipulated by their buyers that they personally believed to be environmentally harmful, out of fear that they would go out of business otherwise (Stuart, 2008).

PES programs commonly use a language of “incentives”, which implies that people are otherwise free to engage in the incentivized activity but need the incentive to increase the desirability of that activity relative to other options. The notion of incentives aligns with the idea that PES payments should reflect the opportunity cost of participating in the incentivized activity (Grima et al., 2016; Wunder, 2007) – for example, the value of alternative land uses in the case

of conservation – which implies that money is the decisive motivator of people’s participation and action.

However, there is mounting evidence that money is not always the only or primary motivation of participation in PES (Chapman, 2017; Olmsted, 2017). More broadly, participation in environmental stewardship has been found to be motivated by a range of factors beyond economic incentives (Schaible et al., 2015). Generally, the notion that people are rational economic actors looking primarily to their own self-interest and accrual of wealth has been largely disproven (Levine et al., 2015). In practice, people are also influenced by many other forces that include identity (Bravo-Monroy et al., 2016; Sulemana and James, 2014) and emotion (Levine et al., 2015). Further complicating the picture, those planning on short time scales (often those who are less well off) may also trade off future benefits to avoid near-term costs (Bell et al., 2016; Pannell et al., 2014).

This suggests that, at least in some cases, it may be helpful to think about PES less in terms of monetary incentives and more in terms of assistance in removing constraints to acting on values. Although many participants in this study appear to be motivated to participate in PES by environmental values (Chapter 4, this dissertation), this analysis suggests that economic concerns may be nevertheless central in constraining the uptake of environmentally sustainable actions, particularly when those actions relate to primary livelihood activities. This is in line with a study of the uptake of conservation practices, which found that uptake was more likely when practices were expected to provide an economic advantage or to be easy to trial (Pannell et al., 2006).

Thus, where potential PES participants are motivated by values, PES may have a greater impact by focusing less on “providing incentives” and more on identifying and “removing constraints”.

While this difference may seem largely semantic, a language of removing constraints might help those implementing PES programs to better-identify program designs that would enable greater participation and lower program costs, particularly among those already motivated by environmental concerns. For example, the Costa Rican PES program has recognized access to large tracts of land as a constraint to participation in conservation and reforestation modalities and has made the program more accessible by introducing an agroforestry modality. Framing PES as “help to remove constraints” might also improve program cost effectiveness by sharing costs with participants. As an incentive, PES imply a transaction where a participant is being paid for a specific action. By contrast, removing a constraint implies a relationship where PES is helping someone do something they already wanted to do, where the PES program and participant are working towards a common goal. This in turn implies a shared investment in reaching that goal, where a potential participant is willing to contribute some of their own time or resources (Chan et al., 2017a). Unfortunately, constraints are likely highly context-dependent, implying that understanding them could involve significant investments in research prior to implementing a PES program. Flexible PES designs that allow ES providers to suggest actions they wish to undertake, such as reverse auctions (Stoneham et al., 2003), could address this issue by allowing potential participants to identify their context-specific constraints and propose what they see as desirable, cost-effective solutions.

5.4.3 PES and livelihood activities

This study highlights a potentially important distinction between incentivized activities in PES programs: activities involved directly in primary household livelihoods, and those that are secondary or in parallel to primary household livelihoods. Many PES programs focus on activities that include protection and reforestation. For households whose primary livelihood activity is farming, these activities necessarily must happen on land that is separate from the agricultural activities that are central to their livelihoods. In San Carlos, protection is by far the dominant PES modality. Agroforestry practices, which more feasibly share space with dairy farming, are less common. As described above, there is evidence that environmental values do not translate into the use of more environmentally sustainable farming practices in San Carlos. Regressions suggest the hypothesis that wealth and modern value chain participation may constrain uptake of these practices. Together, these findings indicate there may be considerable untapped potential to increase the impact of Costa Rica's PES by using payments to remove constraints to the adoption of more sustainable farming practices. While PSA in Costa Rica has introduced a new tree planting modality, this study suggests that there may be scope to support greater uptake of other more sustainable agriculture practices, such as reducing the use of chemical inputs and improving waste management.

Designing PES to include more activities directly connected to livelihood activities could both offer more opportunities for lower cost conservation and increase the accessibility of PES.

Evidence in San Carlos that farmers have environmental farm management goals and considerations suggests that connecting PES to livelihood activities could offer more opportunities to secure shared-cost stewardship action. As described above, farmers who already

want to engage in more sustainable farming practices would likely be willing to co-invest their time and resources to adopt these practices with support from PES. PES for activities connected to livelihoods could also allow more people to engage in PES, since participation wouldn't be limited to those who had a sufficiently large piece of land to viably participate. For example, a farmer with a small parcel of land all in current use for dairy farming would likely not participate in protection or reforestation PES because that would take land away from their primary income generation. However, that same farmer might be able – and want – to participate in a PES program that helped them to fence cattle out of the stream on their farm and set up an alternative watering system for their cattle. More research would be needed to understand what kinds of support – monetary and otherwise – would allow people to adopt new agricultural practices while continuing to meet their livelihood needs and operate efficiently and sustainably within the constraints of their preferred dairy market.

We expect that both PES incentivizing activities connected to primary livelihoods and PES incentivizing separate or secondary activities can make important contributions to sustainability. Given that many PES programs focus on activities like protection that exclude livelihood activities, there is likely particular room to expand PES that are connected to primary livelihood activities. At the same time, we can imagine situations where PES incentivizing secondary activities might be more appropriate. For example, given that attitudes towards risk can influence the adoption of agricultural practices (Abadi Ghadim and Pannell, 1999), it is feasible that some potential participants would perceive participating in PES involving their primary livelihood activities to be too risky. In this case, PES activities that are separate from livelihood activities might be more appealing. PES activities separate from livelihood activities could also act as a

“gateway” to introduce people to a PES program and demonstrate how it might work for them. This could be important, given that demonstrations and experimentation are understood to facilitate the adoption of conservation practices and agricultural innovation (Abadi Ghadim and Pannell, 1999; Pannell et al., 2006).

5.4.4 Modernized value chains and sustainable farming practices

Together, PES and modern value chain participation regression results lead us to hypothesize that the requirements of farmers’ dairy markets are important drivers of their use of inputs and environmental farming practices. In San Carlos, participation in a modernized dairy value chain was associated with higher odds of using inputs, and non-significant or lower odds of using more environmentally sustainable farm management practices. While increased input use reflects findings in other studies of modernized value chains (Barrett et al., 2001; Ruben and Sáenz, 2008), these findings are arguably at odds with public commitments to improve environmental sustainability made by the firms and cooperatives in these value chains.

We expect that this disconnect between sustainability commitments and sustainable agricultural practices likely exists in part because firms and cooperatives are engaging in sustainability actions that do not involve suppliers. Some of the sustainability commitments made by firms and cooperatives are broadly stated and do not detail specific actions that are being taken. For example, Sigma commits to “using resources more efficiently” (Sigma, 2018) and Coopebrisas’ vision includes “the protection and conservation of environmental resources” (Coopebrisas, 2018). Where details are given, initiatives tend to involve a level of the value chain other than supply – for example, FIFCO describes a program to recycle product packaging (FIFCO, 2015).

Other supported sustainability initiatives happen outside of the value chain – for example, Dos Pinos’ program of “Acciones para los Colaboradores” supports sustainability projects, like reforestation, done in collaboration with other organizations (Dos Pinos 2017).

Notably, none of these companies or cooperatives specifically mentions producer-level sustainability initiatives, despite the significant environmental impacts of agriculture (FAO, 2017a) and the importance of agriculture to global sustainability (Chapter 1, this dissertation). A Dos Pinos employee said that environmental training was given to producers by Dos Pinos, and producers confirmed it was available; however, we did not ascertain to what extent this training was attended and implemented by producers. As described above, the agricultural practices included in this study have been identified by experts as important concerns for agricultural sustainability. The fact that environmental farm management practices were used no more frequently in modernized markets, and that inputs were used more frequently, suggests that the translation of firm and cooperative commitments to environmental sustainability into actions could be improved considerably at the supplier level of these dairy value chains.

Firms in food value chains can support supplier uptake of novel practices and participation in more sustainable farm management practices, for example via economic mechanisms, information exchange, and the creation of shared visions (Gomez et al., 2011; Hartmann, 2011; Mylan et al., 2015; Zanello et al., 2015). More research would be needed to understand why dairy firms operating in San Carlos don’t appear to be prioritizing agricultural sustainability. We hypothesize that firm and cooperative value chain actors, like farmers, are also constrained by the pressures and characteristics of their markets. In interviews, Costa Rican dairy key

informants described increasing competition in the dairy industry, including the entrance of multinationals from other countries into the Costa Rican market. They described pressure from economic forces beyond their influence, like increasing costs of imported inputs used widely in the industry. Public commitments to sustainability and other forms of CSR tend to have public relations and marketing motivations alongside sustainability motivations (Newell and Frynas, 2007). This means that firms will tend to focus on initiatives that reflect the demands and desires of their consumers, and thus improve marketability of their products (Fuchs et al., 2011). While further research would be needed to confirm this hypothesis for the Costa Rican case, we expect that multinational firms like Dos Pinos and Sigma choose to focus on implementing their CSR commitments in ways that maximize marketing impact while minimizing cost to the company. It may be that supporting the adoption of more sustainable agricultural practices by their producers does not meet these criteria, either because agricultural sustainability is not a priority of their customers, or because shifting their producers towards more sustainable practices is perceived to be too costly in the current market environment.

However, as firms become increasingly important players in the governance of global environmental sustainability, CSR cannot make a sufficient contribution to sustainability if actions do not address value chains (Newell and Frynas, 2007). Given the importance of agriculture to global sustainability outlined in the introduction of this paper, we would also suggest there is significant missed potential when firms in food value chains leave producers out of their sustainability initiatives. It is unlikely that private governance initiatives alone will be sufficient to address sustainability challenges (Dauvergne and Lister, 2011; Fuchs et al., 2011; Fuchs and Kalfagianni, 2017); where important issues like agricultural sustainability are not

being addressed by private governance initiatives, this raises the question as to how firms might be incentivized to engage in initiatives understood to be central to global sustainability (in addition to, or instead of, those actions that best support their marketing goals). Given that value chains appear to influence the farming practices of the farmers who supply them, we can imagine that a PES that engaged other value chain actors alongside producers could have the potential to make important contributions to global sustainability. However, firms have not widely engaged in PES (Chan et al., 2017a), meaning more research would be needed to understand why and how to engage these actors. In light of the influence of consumers in shaping the CSR activities of firms, one possibility might be to engage entire value chains, from producers to consumers, in PES-inspired initiatives that facilitate, reward, and share responsibility for environmental stewardship (Chan et al., 2017a).

By looking at dairy market participation alongside PES participation, this study highlights markets as, not surprisingly, a likely key constraint on advancing agricultural sustainability. Economic concerns connected to primary livelihood activities, and to value chain activities in the case of firms, appear to be trumping environmental action at the farm level. For global sustainability, it will be important to continue to explore how environmental initiatives might better support and secure agricultural sustainability. We suggest that PES and PES-inspired programs that involve primary livelihood activities and entire value chains could be part of the answer.

Chapter 6: Conclusion

There is wide recognition that sustainability is unlikely to be achieved without both human development and environmental stewardship, and that farmers and agriculture are key pieces of these puzzles. An increasingly globalized world has fostered new connections and relationships, linking people across further distances in novel ways. There is a desire to bring farmers into these new relationships with a goal of improving human and/or environmental wellbeing. This dissertation has explored farmer participation in two of these potential mechanisms for increasing human development and environmental sustainability: modernized food value chains and payments for ecosystem services (PES).

Two research objectives underpinned this dissertation: understanding the human and environmental implications of farmer participation in modernized markets and PES when a broad approach to wellbeing is taken; and, exploring whether there is value in considering farmer participation in modernized value chains and PES together. I have found that taking a more expansive approach to wellbeing that moves beyond income effects reveals that both PES and modern food value chains influence both environmental and well-being outcomes, but not always as intended. This research as a whole suggests that thinking about modern food value chains and PES together has value in highlighting common and interconnected challenges, and in inspiring thinking about how farmer participation in PES and modern value chains might be combined in complimentary ways to further sustainable development goals.

In this concluding chapter, I first reflect on the contributions and significance of this dissertation, discussing my findings in the context of five themes. I then discuss several limitations to my research, along with suggestions for how similar studies might improve on my approach. Finally, I share some thoughts on potential applications and directions for future research.

6.1 Research contributions and significance

Whereas many studies of farmer participation in modern food value chains and PES programs focus narrowly on one or a few indicators of human or environmental wellbeing, this dissertation took an expansive approach. Focusing on income, as is common in economic studies in particular (e.g., Barrett et al., 2012; Bellemare, 2012), can imply that these opportunities are largely beneficial. In Chapters 2 through 5, a broad approach to wellbeing suggests that participation in modern value chains and PES can have both positive and negative implications for the wellbeing of people and their environment. Section 6.1.1 expands on this contribution.

This dissertation also supports the importance of linking economic and environmental considerations and governance for sustainable development, an idea that has been presented by multiple authors (Biermann et al., 2012b; 2012a; Lipper et al., 2014). Sections 6.1.2-6.1.5 discuss insights from considering modern dairy value chains and PES together in the Costa Rican case.

6.1.1 A broad approach to wellbeing highlights complexity and context-dependence

The Costa Rican case demonstrates that participation in modern food value chains and PES programs may increase indicators of adaptive capacity and intangible wellbeing, but likely at the

expense of independence and equity. Chapter 2 describes probable positive contributions to adaptive capacity from participation in modern dairy value chains, while Chapter 4 suggests positive contributions to intangible aspects of wellbeing from participation in the national PES program. At the same time, Chapter 3 points to potential negative implications of participation in modern dairy value chains that include loss of independence and negotiating power. Chapters 2, 3 and 4 suggest that both modern food value chains and PES programs can reinforce inequity between participants and non-participants. Chapter 5 shows that participation in modern dairy value chains may have negative implications for the use of more sustainable farming practices.

The findings in this dissertation support the many voices that caution against viewing any development or conservation strategy as a panacea, and emphasize context-dependent solutions (Berdegué et al., 2015; FAO, 2015; Gereffi, 2014; Ostrom et al., 2007). Chapters 2 and 4 gives evidence that farmers with access to different resources have different abilities to access modern value chains and PES programs. In Chapter 4 I show that different groups of cattle farmers perceive (and are likely motivated by) different benefits of participating in PES, likely reflecting their different contexts. Chapter 3 provides insight into how the characteristics of value chain and PES opportunities may affect wellbeing. The chapter describes how a producer cooperative controlling a modernized value chain can potentially increase producer voice and participation in decision making compared to value chains controlled by private firms. It also details how modern value chains with firms that approach producer relationships with goals of creating ideal, long-term suppliers through investment and support might translate into better producer experiences in these value chains compared to those with firms who focus on short-term efficiency maximization. In short, farmers are unlikely to benefit from modern value chains and

PES programs simply because they have access to them. In using participation in modern value chains and PES programs as mechanisms to advance human wellbeing and environmental sustainability, it will be helpful to consider the formal and informal characteristics of the food and PES value chains, including their actors and the relationships between them, and how these characteristics shape producer experiences in these value chains and wellbeing outcomes for both humans and the environment.

6.1.2 Primary livelihood activities are key in shaping outcomes

This dissertation highlights that modern food value chains may trump PES programs in their importance to household livelihoods and effect on environmental practices. Chapters 4 and 5 present evidence that PES participation is secondary to dairying in importance and influence with respect to household income sources and farm management practices. This has implications for household decision-making and agricultural sustainability. The importance of agricultural income relative to PES (Chapter 4) suggests that when households feel economic pressure, decisions may be more strongly influenced by their agricultural livelihood, a hypothesis that appears to hold up when findings from Chapters 4 and 5 are brought together. Chapter 4 found that a majority of PES participants in San Carlos perceived environmental benefits from participation, suggesting that environmental values and a desire to participate in environmental stewardship were likely motivating participation in PES, at least in part. In contrast, Chapter 5 showed that PES participation didn't correlate to a higher rate of use of sustainable farming practices, despite evidence that PES participants appear more likely to have environmental considerations and goals shaping their farm management choices. Where dairy farmers were involved in modern dairy value chains, they were less likely to use more sustainable farming

practices, even when they were participating in PES. I thus hypothesized that dairy value chain requirements and pressures constrain choices about farming practices, trumping environmental values where present.

If primary livelihood concerns are indeed trumping environmental values, there may be other connected diffuse or delayed negative consequences for wellbeing. Perhaps most obvious are the potential human health concerns associated with some less sustainable farming practices, like chemical pesticide use (García-García et al., 2016; Kim et al., 2017). Other potential wellbeing effects could be more difficult to measure. Agency and autonomy are thought to be important to human wellbeing (Ryan and Deci, 2000; Welzel and Inglehart, 2010), and are factors that Chapters 2 and 3 suggest may be reduced by participation in modern value chains. At the same time, studies of PES programs suggest that there are wellbeing benefits associated with the ability to act on perceived environmental responsibilities and identify as someone who cares about the environment (Arriagada et al., 2015; Ortiz Malavasi et al., 2003). This implies that where agricultural livelihood activities, including modern value chain participation, restrict farmers' ability to freely choose the agricultural practices they use, there may be further negative consequences for wellbeing. Constraints on farming practices from modern value chain contracts and standards are fairly well documented (Berdegue et al., 2005; Handschuch et al., 2013). However, few studies discuss how these restrictions affect wellbeing, suggesting that further research would be both interesting and prudent to explore how constraints from modern value chains shape both tangible and intangible aspects of wellbeing, including the health of producers and local agroecosystems, and intangible wellbeing factors associated with farmers' freedom to choose their own farming practices and act on their values.

From an environmental stewardship perspective, these findings suggest that PES programs might achieve greater gains by working within the constraints posed by the constraints primary livelihood activities place on farmer choices and subsequent environmental stewardship action. By understanding existing constraints on farmer land management choices, a PES program might be designed to incentivize less-constrained actions, thereby facilitating the involvement of a greater number of participants. Alternatively, a PES program might include support designed to help producers overcome a specific constraint. For example, in San Carlos, some cooperative producers described needing to use chemical fertilizers on their pastures in order to produce enough grass to support a herd big enough to meet their production quotas. In this case, a PES program might incentivize actions other than reducing chemical fertilizer use, or might include technical support to help producers transition to using animal fertilizers, or to learn alternate ways to increase their efficiency (e.g., rotational grazing).

6.1.3 Intermediaries are an important point of influence

This dissertation supports the view that power in modern food value chains and PES transactions tends to be concentrated with intermediaries (Clapp, 2014; Fuchs et al., 2009; Vatn, 2010). In modern dairy value chains and the national PES program in Costa Rica, multinational food processing companies and FONAFIFO are the controlling intermediaries in modern dairy value chains and the national PES program respectively. Chapter 3 details how dairy firms operating in San Carlos control their supply chain via cooperative agreements and contracts and strict quality standards and testing procedures. Chapter 4 describes how FONAFIFO's administrative requirements for PES participation translate into fixed transaction costs that favour landowners

who can commit larger tracts of land. Chapter 5 argues that the requirements to supply modern dairy value chains – determined by dairy processing companies – may constrain producer choices of farming practices.

This concentration of power would suggest that intermediaries would be a key, if not primary, point of engagement for improving human and environmental wellbeing outcomes when farmers participate in modern value chains and PES programs. Yet, many initiatives to connect producers to modern value chains and most PES programs focus on the level of producers and their communities. Ignoring the influence of intermediaries can have negative consequences. For example, Elder (2016) describes how an NGO in Nicaragua facilitated the formation of cooperatives to help producers access market opportunities selling fresh fruits and vegetables to Walmart. In the end, many cooperatives became unstable and a majority of producers stopped selling to Walmart, largely because the NGO did not consider how and whether Walmart's approach and business priorities aligned with farmer interests and the NGO's development goals. Similarly, most PES programs are also focused on the local level. Despite increased global interest in sustainability by manufacturers and retailers (Dauvergne and Lister, 2011), firms remain largely unengaged in PES, thought to be connected to issues that include uncertainty and unfamiliarity with these transactions (Chan et al., 2017a).

Given the influence of intermediaries, it is likely that rural development initiatives and PES might both benefit from more intentionally and thoughtfully engaging intermediaries.

Chapter 4 argues that firm approaches to relationships with producers that emphasize long-term relationships and investment in suppliers (a “Create and Relate” approach) likely result in more

positive producer experiences in these value chains. Development initiatives seeking to connect farmers to modern food value chains might benefit from more closely engaging with firms to understand whether they approach producer relationships in a way that is likely to be compatible with desired development outcomes. It might also be beneficial to explicitly include firms in value chain participation initiatives, perhaps with a goal of moving firms to adopt approaches to supply relationships that are more likely to benefit producers. Finally, where people's ability to act on environmental values is constrained by modern value chain requirements, it may be possible to expand the impact of PES programs by including and incentivizing firms alongside farmers. I expand on this idea in Section 6.3.2 below.

6.1.4 Unequal access is a central challenge

In the Costa Rican case, a central challenge with both modern dairy value chains and the national PES program was shown to be unequal access to these opportunities and associated potential benefits. In Chapter 2, I presented evidence suggesting that being better off across several adaptive capacity indicators likely helps people to access modern dairy value chain opportunities, and that these opportunities then likely enhance adaptive capacity across multiple indicators. Similarly, Chapter 4 showed that those who are better off are likely better able to access PES in San Carlos. These findings suggest that both modern dairy value chains and the PES program may be reinforcing inequity. Chapters 2-4 show that this phenomenon is not uncommon in the literature on modern food value chains and PES programs. These findings are important, given that equity is understood to be a requirement for sustainable development (Biermann et al., 2012a).

In part, this similar tendency to reinforce inequity could be because of the parallel structures of modern value chain and PES transactions. In both cases, the terms of the transaction are largely dictated by the intermediary, who is generally distanced from the local reality of potential participants, and who has goals that don't necessarily include or prioritize producer wellbeing directly. The intermediary also presumably has their own set of constraints, like global market conditions and consumer preferences, and program constraints in the case of PES (Bosselmann and Lund, 2013). The ability of the producer to negotiate terms that are more favourable to their specific circumstances tends to be limited. As a result, it is often only producers with certain characteristics that are able to meet the set terms of the modern value chain and PES transactions.

While neither the development or environmental stewardship communities can claim to have solved equity issues, I see the potential for idea-sharing, as each group has, at least to some extent, approached the problem from different angles and drawn on different expertise. For example, producer cooperatives and collective action are a common theme in the market participation literature. Cooperatives are understood to help producers achieve economies of scale that allow them to access modern value chains (Barrett et al., 2012). While some PES programs have attempted community-level payments and programs, studies of PES programs engaging existing producer cooperatives are few to non-existent. The market participation literature includes many studies on both collective action and the adoption of novel agricultural practices that could provide inspiration.

At the same time, Chapter 3 points out how cooperatives also create an out-group of non-cooperative members who cannot access these benefits, which can also reinforce inequity. Here, value chain participation initiatives might benefit from seeing how some PES programs have addressed dual environment and development goals by supporting concurrent development programs rather than seeking participation in PES for all community members. For example, Global Woods, a company engaged in tree planting to generate income from carbon PES in Uganda, initially aimed to include local community members in tree planting activities on their own land to generate income from PES alongside the company's commercial planting program on national parkland. However, they were struggling to design a program that was widely accessible in the community. So, instead of involving community members in a carbon forestry project with development goals, they instead partnered with a local development organization to implement a more widely accessible and targeted local development program that was funded by earnings from their commercial carbon forestry venture in the park (Anderson, 2010). Gomez et al. (2011) also suggest that there can be positive indirect effects of modern value chains on development for non-participants, an idea that has room for further exploration with respect to both food value chains and PES. These ideas also align with suggestions that PES is more likely to achieve dual human and environmental goals as part of a broader policy approach (Muradian et al., 2013). Similarly, it is feasible that value chain participation initiatives may be more successful at realizing equitable development when part of a broader rural development approach.

6.1.5 Relationships and values mediate participation and experiences

In contrast to the focus of modern value chain and PES literatures on instrumental approaches to explaining producer participation and satisfaction, this dissertation finds evidence that relationships and values are important aspects of these transactions. Chapter 3 provides evidence that, beyond the formal contracts and standards that govern producer engagement with modern dairy value chains, firm priorities and approaches to relationships with producers can shape producer experiences and outcomes, complementing studies that suggest producer relationships with buyers have implications for wellbeing (Gereffi and Luo, 2014). In Chapter 2, findings that some producers explain that they choose to sell via Dos Pinos because of “tradition” and “inheritance” suggest that non-economic values may also be important factors in motivating market choices. Similarly, in the case of PES, Chapter 4 shows that environmental benefits are important to PES participants in San Carlos, supporting other studies of PES programs that have found environmental outcomes and motivations to be more important to participants than economic benefits (Arriagada et al., 2015; Ortiz Malavasi et al., 2003).

These findings support the notion that human decisions and actions are not tidily economic and rational (Levine et al., 2015), including in the case of farm management; for example, a recent study found that social recognition and identity drove farmer decisions alongside economic influences (Bravo-Monroy et al., 2016). These findings support building momentum in the conservation community to explore and better understand more intangible aspects of our human-environment relationship, like cultural ecosystem services (Chan et al., 2012; Chan et al., 2012; Gould et al., 2014; Satterfield et al., 2013) and relational values (Chan et al., 2016; Klain et al., 2017; Pascual et al., 2017), and calls to consider how PES and other environmental stewardship

programs might better harness and support existing environmental values (Chan et al., 2017a; Chapman, 2017; Duff et al., 2017; Olmsted, 2017). They lend weight to studies and approaches that emphasize that relationships are important – and even central – to understanding how people interact with each other and with ecosystems, and to understanding transformational change (Darnhofer et al., 2016; Robalino and Pfaff, 2012). In short, we might see greater success in realizing hoped for outcomes for human wellbeing and environmental sustainability from participation in modern value chains and PES if we thought more about values and relationships.

6.2 Limitations

6.2.1 Causality and sampling

Establishing causality is a common difficulty in participation studies. One of the biggest reasons for this difficulty is that producer participation in value chain opportunities is not random; rather, it is influenced by a variety of (sometimes difficult to measure) factors that can include access to inputs, the location of intermediary value chain actors and facilities, producer attitudes towards risk and novelty, intermediary preferences for larger-scale suppliers, and producer social networks and abilities (Barrett et al., 2012). Participation can be influenced by unobservable as well as observable influences: for example, producers may choose not to sell into modern value chains if they perceive intermediary firms to be acting unfairly (Elder and Dauvergne, 2014). Barrett et al. (2012) describe in detail how the nonrandom inclusion of farmers in modern value chains can bias regression results. For example, a farmer may choose not to engage in a modern value chain or PES because they prefer not to be constrained by the terms of the contract that is a requirement to participate. This decision not to participate could reflect an entrepreneurial attitude, which could benefit the producer (for example, by helping him or her to generate a

higher income). This in turn would negatively bias a regression result looking at how participation affects income (Barrett et al., 2012).

It may also be difficult to disentangle the direction of relationship between participation and various wellbeing factors, particularly in cross-sectional studies of participation (Bellemare, 2012). In a cross-sectional study, like this one, a single survey provides a snapshot in time. The effects of participation are explored by comparing non-participants to participants in the survey sample. In this case, it can be difficult to determine empirically whether observed differences facilitate participation or are caused by participation, or both. For example, in Chapters 2, qualitative data suggests that having greater wealth likely helps producers to access modern value chains, and that modern value chains also help to increase producer wealth relative to other dairy markets. Wellbeing factors can also interact; for example, having greater wealth may allow a farmer to achieve higher education, which might in turn help the farmer to manage their farm more efficiently and generate greater wealth.

I encountered many of these challenges in my study. As described in my study methods, opportunities to participate in different value chains were not evenly distributed across the study area. All modern value chain opportunities were concentrated in the south of San Carlos, and few collection routes ventured far along rural back roads. Farmers located closer to PES intermediaries and to modern dairy value chain collection centres likely had greater access to these opportunities. As such, restricting the survey to the south of the cantón and planning survey routes that primarily followed more major roads likely eliminated farmers who had no opportunity to sell to a modern value chain based on their location. While this means the survey

cannot shed light on difference between producers with and without access to modern value chain opportunities, it meant that results were likely less influenced by the inclusion of farmers who had no possibility of participating in modern value chains or PES in non-participant groups.

Within the south of the cantón, different modern dairy value chains were sourcing in different parts of San Carlos based on the location of their processing and collection facilities. This means that producers had access to different modern value chains based on their locations. There is geographic variation in altitude and climate conditions within the south of San Carlos, with the area around Quesada tending to be higher, cooler, and wetter, and getting lower and dryer heading west in the cantón. These differences favour different cattle varieties and farming practices, with specialized dairying more common near Quesada and dual-purpose herds (meat and dairy) more common in the dryer regions in the west (Vargas-Leitón et al., 2013). There is also likely some geographical variation in socioeconomic characteristics across the cantón; for example, key informants said that many wealthier dairy farmers lived close to Quesada, while farmers close to the cantón border in the west tended to be less wealthy. This makes it difficult to fully disentangle the causes of variations in wellbeing and farming practices between different modern value chains. For example, while significantly higher prices paid for milk by Dos Pinos versus Sigma provide some justification in attributing wealth differences between farmers in these value chains to their value chains, at least in part, the size of this effect is less clear given that Sigma may be sourcing from a less wealthy region of San Carlos. Producers supplying traditional value chains were somewhat more evenly dispersed, which would have reduced this issue in this sub-group.

My results also may have been influenced by the multistage sampling approach I used. While this approach assisted in adequately representing several small sub-populations in my sample, it meant that some groups, like PES participants, were over-represented in my sample compared to the population. I also targeted PES participants within each sample area, because after cross referencing lists of PES participants with lists of dairy farmers I realized that the sub-population of dairy farming PES participants was quite small (around 100 in all of San Carlos), and I wanted to ensure sufficient representation in my sample. I expect that targeting PES participants could have had some benefits in terms of helping to control some of the challenges with geographic variation described above, in that I included PES participants and non-participants living and producing in close proximity, who presumably would have had more similar climatic and socioeconomic contexts. At the same time, I expect the sampling approach likely underestimated certain differences between PES participants and non-participants, like differences in distance to the major commercial centre.

Combining quantitative and qualitative data, and the breadth of data collected, helped to address some of these methodological challenges. While my study design did not allow me to establish causality empirically, qualitative data allowed me to make some reasonable hypotheses about causality and the mechanisms underlying observed patterns, including problem solving some unexpected survey results. For example, on the surface, it was puzzling that many producers, particularly those selling via Dos Pinos, identified the price they received for milk as both a benefit and challenge of their dairy market. Qualitative interviews and informal conversations with producers during surveying revealed that while many producers were quite satisfied with the prices they received relative to dairy producers in other markets, they were concerned with

trends in milk prices overall, which had been decreasing relative to their input costs. Qualitative data also helped me to understand what variables were likely to be more strongly affected by geographic differences. For example, I chose not to include irrigation use in my analyses. Farmers explained to me that irrigation use was influenced by multiple factors that included dairy market, but also wealth, dairy farm type (irrigation is more common on specialist dairy farms than on dual purpose farms), and local climate (wetter areas had less need to irrigate); this multitude of factors would likely make it extremely difficult to disentangle the influence of dairy market participation on irrigation use.

Although my survey design had benefits, I see several potential ways future studies could improve upon it. First, longitudinal studies that surveyed and interviewed producers before, during and after participation in PES and in different food value chains could much more reliably discern changes that were happening as a result of participation, and thus more rigorously establish causality. Returning to San Carlos in 5-10 years to re-survey my sample would likely be enlightening. Second, my sampling, particularly the inclusion of participants in different modern value chains, would likely have been greatly improved by having access to company supplier lists. I did not manage to survey as many producers supplying Sigma and Coopeleche as planned. I had thought that combining recent (previous year) government cattle farm census data with local knowledge from extension workers and producers about areas supplying different markets would allow me to survey a sufficiently large number of farmers in different markets. However, the SENASA data had a high number of errors (surveyors visited many farms that had not been dairy farms for many years), and local knowledge about company supply areas proved inaccurate. With supplier lists, I would have been able to generate a more reliable plan for

sampling from all value chains, with the ability to substitute a supplier from the same market when a targeted farmer was unable or unwilling to participate. Without supplier lists, sampling might have been improved by pre-surveying the area to identify dairy farms and their markets, then using this information to generate a random sample for the main survey; however, this would have significantly increased the cost of already expensive data collection. Third, a larger sample would have allowed me to more effectively detect statistically significant relationships while controlling for more factors, like geographic location and associated differences. I could have also specifically collected or included data on more of the variables expected to vary regionally, like climatic variations, soil variations, etc.

Finally, establishing causality would likely have been improved by designing the study like a treatment effect study. Treatment studies are common in health intervention research, but only beginning to appear in participation studies (Mojo et al., 2017). In this type of study, an opportunity like a modern value chain or PES program is considered the “treatment”. There are then three groups – those who have a modern value chain or PES program operating in their area and choose to participate; those who have the opportunity available but don’t participate; and those who don’t have the opportunity available. A survey could specifically ask what market options are available to each producer or make assumptions based on producer access to modern market collection routes, if that information was available. This could be coupled with questions designed to understand how and why producers chose between the options available to them. In the case of PES, non-participating producers could be asked if they know about the PES program to differentiate those who have access versus those who do not. By comparing the different groups and their characteristics, it would be possible to better understand what affects

participation where opportunities are available, including both tangible constraints on participation and factors that influence farmer choice to participate, and assist in determining whether correlations with participation facilitate participation or are the result of participating. As well, this type of study could shed more light on how the availability of these opportunities is distributed both geographically and among groups with different demographic characteristics.

6.2.2 Generalizability

Because the details and effects of market participation and PES programs are understood to be highly context-specific, a central question in many market participation and PES studies is: how generalizable are these findings to other situations? Not only was I unable to statistically establish causality, generalizability is also impeded by the rather unique characteristics of Dos Pinos as a multinational producer cooperative.

On the other hand, Costa Rica has one of the longest running PES programs in the world, and Latin America is at the forefront of global food system transformation, meaning that it is likely that those aiming to increase participation in modern value chains and PES elsewhere can learn from this case. The food system transformation in other developing regions is showing many of the same patterns seen in Latin America (Reardon et al., 2012), suggesting that studies in Latin America may have value in foreshadowing patterns in other parts of the world. Learning may also be more transferable to countries with similar development profiles to Costa Rica (IFAD, 2016).

While results from this study may not be directly applicable to other places, it is plausible that this case study can usefully contribute by giving researchers and practitioners “food for thought”. Rather than providing a directly applicable set of rules, studies like this one might be more usefully applied as inspiration to help those working in other places to think more thoroughly and deeply about their specific cases, to help them to ask important questions, and to give them more ideas as starting points for problem solving.

6.2.3 Research framing

This research has a largely economic and behavioural framing. It makes the implicit assumption that farmers and their families make choices about their livelihoods that are influenced and constrained by who they are and their contexts, and that these choices affect the social-ecological system of which they are part. This approach is common in studies of participation in modern food value chains and PES programs.

However, it is not universally agreed that the individual or household level – and individual choice – is the appropriate level of focus in discussions of sustainability. For example, social practice theorists suggest that transformation towards sustainability doesn’t happen as a result of individual choices and behaviour change, but rather happens via changes in social practices – actions, like daily showering, that are carried out by people more because it is what people do in a particular social context, rather than because these actions are actively chosen by an individual (Shove, 2011; 2010; Shove and Walker, 2010). Chapter 4 of this dissertation lends support to a growing number of voices that suggest that, beyond the generation or protection of target ES, an important contribution of PES programs may be the reinforcement and demonstration of

environmental values, potentially contributing to changes in social norms and values around environmental stewardship (Chan et al., 2017a; 2017b). In thinking about PES as a contributor to social change, it is feasible that novel insights could be gained by studying PES (and potentially modern value chains) and its contributions to environmental sustainability using alternative approaches and lenses.

6.3 Applications and future research directions

6.3.1 In the Costa Rican context and beyond

This research is most directly applicable in San Carlos and to the dairy sector and FONAFIFO's PES program around Costa Rica. It will be important for dairy farmers and those with an interest in their welfare (e.g., agricultural extension workers, firms seeking Costa Rican dairy suppliers, agencies engaged in rural development, PES intermediaries and facilitators) to understand how dairy farmers can participate well in these opportunities. This research could be particularly useful to those at FONAFIFO looking to improve the PES program's performance in fulfilling its social mandate.

Within Costa Rica, further research could usefully build and expand on this study. This research focused on the farm household level, and on dairy farmers filling similar roles on their farms (i.e., farm owners and/or managers). Additional research, particularly more detailed qualitative studies, would likely be useful to better understand the influence of factors operating beyond the household level, such as governance and social norms and identities. Further research to explore the nature and nuances of power relationships in value chains could be particularly useful to compliment and build on the research presented in Chapter 3. Additional studies to understand

the implications of modern value chain and PES participation for others connected to farms, like non-farming household members and full-time and seasonal employees, could expand understanding of the implications of participation for equity and human wellbeing.

As discussed above, caution is merited when generalizing results beyond the case study context; however, the ideas in this dissertation could provide inspiration for additional research and improvements to PES and value chain development applications beyond the Costa Rican context. Some questions to inspire future research include:

- Are there intermediary or value chain characteristics that tend to favour producer-firm relationships that benefit both firms and producers in different contexts?
- How can intermediary firms be induced to design their operations, including their approaches to relationships with suppliers, in ways that favour better outcomes for sustainable development?
- How might intermediary firms be moved to incentivize and support the use of more sustainable agricultural practices among their suppliers?

In the next section, I expand on this last question, presenting some final thoughts on what linking PES and modern food value chains might look like in practice, with suggestions for future research towards this possibility.

6.3.2 Linking PES and modern food value chains

Bringing together explorations of modern food value chains and a PES program suggests opportunities to improve agricultural sustainability by connecting environmental interventions more squarely to value chains and producer livelihoods. In San Carlos, modern food value chains

and the PES program engage many of the same farmers. At the same time, modern value chains could restrict the ability of PES to reach its full potential in helping Costa Rica realize its environmental goals by constraining the activities that farmers are willing and able to participate in. Chapter 4 suggests that one way the Costa Rican PES program could make itself more accessible to farmers who struggle to participate in protection and forestry modalities that require land commitments could be to expand into incentivizing activities that are more compatible with farming activities. One possibility is to use PES to support the use of more sustainable farming practices including improving waste management and reducing the use of chemical inputs. Given findings in Chapter 5 that suggest modern value chains may constrain farmers' ability or willingness to use more sustainable farming practices, it is feasible that participation in modern food value chains could restrict participation in PES that were targeting agricultural sustainability.

At the same time, multiple authors describe how firms are playing an increasingly important role in environmental and social governance (Dauvergne and Lister, 2011; Fuchs et al., 2011). In this context, Bernstein and Cashore (2012) suggest that it will be important to create “non-state market driven” systems of environmental governance, consisting of stakeholders in and affected by value chains that share responsibility for how products are brought to consumers along the value chain. This raises the questions as to whether PES might accomplish this in modern food value chains, and how. Given the power and influence of intermediary firms, I imagine that the scope and impact of a PES program might be improved significantly if producer participation in PES was supported by modern value chain firms.

In Chapter 5, I describe how firms in modern dairy value chains in Costa Rica appear to be focusing on non-value chain activities and non-agricultural parts of the value chain to realize their public commitments to sustainability. Thus, to effectively engage firms in PES, further research would be necessary to better understand why firms aren't engaging in sustainability activities at the level of their producer suppliers and what might move them to support farmers in engaging in environmental stewardship. A PES program could then be designed to support complementary actions along the value chain. Similar to farm-level PES programs, a reverse auction process could help to overcome obstacles to firm participation and support for producer-level stewardship by allowing value chain actors to propose the sustainability actions they want to take – actions that presumably would be both viable and desirable to the value chain actors. Support could involve monetary or technical support, and/or could also involve non-monetary support, like sustainability branding and publicity for the value chain and its actors.

I can imagine how a well-designed value chain PES could have benefits for producers regarding their agency and influence in modern value chains. If firms and producers were required to set common environmental stewardship goals and apply to PES programs together, programs could help to enhance firm-producer relationships, potentially giving producers a stronger voice in their value chains and promoting relationship longevity. Strengthening relationships between value chain actors might also reduce some of the distance that is thought to contribute to externalizing the social and ecological costs of production in many modern food systems (Clapp, 2014). As well, market access can drive the adoption of new practices (Ayele et al., 2012; Shiferaw and Okello, 2009), suggesting that linking modern value chains with PES could increase participation in PES generally, given that Chapter 4 suggests that PES participation may

be similar to the adoption of other novel agricultural practices. Equity in access to opportunities would still likely be an issue; perhaps a value chain PES could have a “Gold Standard” level of certification for applications that also included provisions in their proposal to engage and care for the community beyond the modern value chain, in recognition that equity is important for broader sustainability goals.

In connecting PES to modern value chains, it will be extremely important that these connections aren’t just creating new opportunities for powerful actors to use social and environmental mechanisms to gain power and control. However, given the increasing involvement of firms in global environmental governance (Dauvergne and Lister, 2011) and decreasing regional autonomy in the face of globalization (Berdegue et al., 2015), it is also unclear whether environmental sustainability can be achieved in the absence of firm involvement. Multiple scholars have called for the integration of sustainability concerns into global trade, identifying specifically a need for “harmonized systems that allow for discriminating between products on the basis of production processes” (Biermann et al., 2012a, p.53). A value chain PES could fit this bill.

These ideas have been inspired in part by discussions with UBC colleagues about their CoSphere initiative (<https://www.cosphere.net/>); connecting PES to modern value chains might be one way to contribute to the value chain transformation envisioned therein. At minimum, this dissertation lends considerable weight to the underlying assumption that bringing together environmental and economic considerations is both prudent and necessary to realize global sustainability.

6.4 Conclusion

With both the human population and human consumption increasing, and with sustainability challenges like climate change becoming ever more pressing, the desire for widely applicable “magic bullets” for sustainable development is strong. And yet, when we dive into the detail of trying to understand and support sustainable development in practice, laudable goals become entwined in the complexity and diversity of local realities, relationships, and environments.

In the face of this daunting complexity, I imagine that solving sustainability problems will require both specialists – to offer intimate understanding of specific places and processes – and generalists – to understand the big picture and patterns, and how ideas and framings fit together and complement each other. It seems intuitive that feeding the world while securing global sustainability – and other real-world problems – will often draw on understanding gleaned across many different disciplines and ways of thinking. In this light, I posit that the most important contribution of this dissertation is in highlighting the value in the ideas that germinate from bringing together two institutions that are usually separate in both research and practice. Bringing together modern food value chains and PES shows how food value chains and primary livelihood activities might restrict environmental stewardship and PES. This understanding could be crucial in improving the contribution of modern value chain participation and PES as mechanisms for sustainable development.

Universal solutions for sustainability are unlikely. But, perhaps, through working towards better communication and creating more space for the cross-pollination of ideas and thinking outside the box, we might just hasten our progress towards sustainable development.

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Appendices

Appendix A Satisfaction with Life Scale

The Satisfaction With Life Scale (SWLS) is a psychometric tool developed by wellbeing researchers (Diener et al., 1985). It is understood to be one component of self-reported wellbeing, rather than a comprehensive measure (Pavot and Diener, 2008). While there is ongoing debate about the usefulness of self-reported wellbeing measures generally and SWLS specifically (Pavot and Diener, 2008), we included this scale in our survey as an indicator of self-reported wellbeing. We chose SWLS because it is quick to administer, has been used in a wide variety of contexts, and has been found to have high internal consistency and test-retest reliability (Pavot and Diener, 2008; 1993) and to be relatively robust to the influences of a respondent's mood at the time of survey (Eid and Diener, 2004). The scale involves responses to five standardized statements. For this study, statements were presented in Spanish using a translation provided by E. Diener, one of the scale's authors (Diener 2018: <https://eddiener.com/scales/7>, Accessed Feb 6 2014). In English, the scale statements are as follows:

In most ways my life is close to my ideal.

The conditions of my life are excellent.

I am satisfied with my life.

So far I have gotten the important things I want in life.

If I could live my life over, I would change almost nothing.

Respondents are typically asked to respond on a 7-point Likert scale, ranging from 7-Strongly Agree to 1-Strong Disagree, with 4 representing a neutral “Neither Agree nor Disagree”. We presented our statements on a 5-point Likert scale, as per Kobau et al. (2010), as we found in piloting our survey that a shorter scale was better-received in our oral survey format.

Appendix B Wealth Index sensitivity and sub-populations

We suggest two, not necessarily mutually exclusive, possible explanations for why we did not find a significant difference in wealth between PES participants and non-participants in Chapter 4. First, while it may be that PES participants are wealthier than non-participants overall in San Carlos, there may not be a significant difference when only looking at cattle farmers, as we did. Every cattle farmer in our study was an owner and/or manager of farmland, implying a certain baseline of wealth. They were all making at least some income from their cattle; all had access to running water and electricity; all were less than a two-hour drive from a regionally important commercial centre (with a majority being less than an hour away). Second, to facilitate comparison with other studies, we used household and productive assets commonly used in wealth index construction. Wealth indices are commonly constructed with household data collected from a sample of all households in a region or country. The wealth index relies on variation in asset ownership to distinguish households. However, because our sample was from a sub-population that included only farm operations that had reached a certain threshold of wealth (i.e. that had sufficient land, cattle and infrastructure to allow them to produce beyond the household self-sufficiency level and market products commercially), it is possible that there was a lower level of differentiation in ownership of these assets compared to the general population. Alternatively, our wealth index may have missed one or more indicators of wealth important in this particular sub-group, thus making it less sensitive to differences between households.

Identifying and including additional indicators might have improved the sensitivity of our index. For example, ownership of a second dwelling might have been a fruitful indicator to include. In a study of PES participation in Costa Rica that included San Carlos, living off-farm was a

significant predictor of PES participation (Zbinden & Lee, 2005). While not significantly different, we did find a greater proportion of PES participants in our study lived away from their farm, and several of the wealthier farmers we interviewed had their primary residence in town and commuted to their farm. We also found that, while not significantly different, PES participants in our study tended to keep cattle on their farms in lower densities and had a lower percentage of their herd being milked. PES participants may rely less heavily on income from cattle, a similar conclusion to other studies of PES in Costa Rica (Ortiz Malavasi et al., 2003, Morse et al. 2009). This idea is supported by the fact that PES participants also tended to have a greater number of household income streams than non-participants. To improve on the construction of asset-based wealth indices for sub-populations, future studies could develop a standardized protocol for identifying important assets before conducting household surveys.