

COMMUNITY PERCEPTIONS OF ECOSYSTEM SERVICES AND
HUMAN WELL-BEING FROM TREE PLANTATIONS IN ARGENTINA

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ABSTRACT

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Sustainable biofuels have the potential to help lower greenhouse gas emissions while providing socioeconomic benefits to local communities that supply and produce biofuel feedstocks. Global and regional demand for sustainably produced biofuels and renewable energy targets have recently created a market for woody biofuels derived from unused forestry residues in the Argentine forestry sector. Currently, less than one percent of tree plantation residues is converted into biofuel products (e.g., wood pellets) in Argentina, but growing global interest in biofuels may prompt increased tree plantation developments in the region. Little is known about people's perceptions of tree plantation effects on their communities. The purpose of this research was to: 1) investigate how people define and construct ecosystem services, and how they perceive effects of tree plantations on ecosystem services and well-being; and 2) explore how tree plantations are shaped by land tenure and land use history and how this shape people's perceptions of tree plantations.

In Chapter 2, I examine responses gathered from in-depth, qualitative interviews to identify community member definitions of ecosystem services and perceived effects of local tree plantation developments on ecosystem services and well-being. I compared these data with the 2005 Millennium Ecosystem Assessment (MEA) ecosystem services conceptual framework. While respondents defined ecosystem services similarly to the MEA, not all MEA ecosystem services were defined, and some definitions were integrated or altogether novel. Respondents viewed tree plantations as both positively and negatively impacting ecosystem services and well-being, indicating the need to evaluate tradeoffs if tree plantation expansion continues. In Chapter 3, I explore how land tenure and land use history shape tree plantation developments. I also examine people's perceptions of the effects of tree plantation development on land tenure, ecosystem services, and well-being. Results indicate links between land tenure and land use history in determining where and how tree plantations are established. Respondent perceptions align clearly with local land tenure and land use histories. This work contributes to a growing body of literature that explores biofuel sustainability across the Americas.

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DEDICATION

To Aunt Sue, whose belly-filled laughter, snarky wit, and warmhearted soul will forever be remembered. We promise to carry on the family tradition of sloshing rounds of margaritas with rounds of hymns and traditional songs sung boisterously at our favorite local Mexican restaurants.

PREFACE

I plan to submit both my researcher papers for peer-reviewed publication. Thus, each has been formatted as a stand-alone journal article. The use of the pronoun “we” is used to indicate that these manuscripts will include co-authors and each will have its own references section. I plan to submit Chapter 2 to the Journal of Ecosystem Services. I plan to submit Chapter 3 to the Journal of Forest Policy and Economics. Due to formatting requirements for Northern Arizona University, some redundancy exists from combining these articles.

Chapter 1: Introduction

Sustainably produced biofuels offer an alternative to fossil fuels with the potential to lower greenhouse gas emissions (Granda et al., 2007; IEA Bioenergy, 2011; Tilman et al., 2009) and provide economic opportunities to local communities (Williams, 1994). However, societies whose land areas are used to supply and produce biofuel feedstocks risk negative socio-ecological changes (Pimentel et al., 1984). Pimentel et al. (1984) describe these negative socio-ecological changes as water and land resource conflicts with agriculture and forestry production, nutrient loss and soil erosion, rising air pollution levels, increased risk of occupational injuries and illness, as well as increasing prices on land and farm commodities. Other risks include negative impacts on livelihoods, displacement of existing industries, and increasing inequality and poverty (de Castro Santos, 1993; Upham et al., 2007). Some also criticize biofuel developments for decreasing ecosystem services and reducing socio-ecological resilience (Fargione et al., 2008; Flaspohler and Webster, 2011).

National renewable energy targets and biofuel mandates, as well as global demand, drive current biofuel developments across Argentina. As the third largest soybean producer in the world and the first exporter of soybean oil, biodiesel production is expected to increase in the country (Panichelli et al., 2009). At the same time, government incentive programs encourage investment in and expansion of tree plantations, a potential source of bioenergy feedstock identified by the Argentine government (Sánchez Acosta, 1999; Secretaría de Energía, 2009). Many of the benefits and risks associated with biofuel production described above parallel those described by studies focused on tree plantation developments (Bardomás, 2007; Cabbage et al., 2010, 2007; Paruelo, 2012). These parallels are expected as land use change is the primary driver for supporting both biofuel production and tree plantation installation, and changes in land use drive changes in ecosystem services and human well-being.

Tree plantation establishments are expanding across Latin America (FAO, 2015a). In Argentina, the area of land dedicated to tree plantations increased by 40% between 1990-2015, now covering over one million hectares (FAO, 2015b). Traditionally serving as fast-growing feedstocks for timber and wood pulp for paper, renewable energy goals in Argentina provide a new end use for tree plantation woody residues. In 2015, the first large-scale renewable energy project using woody residues opened in the city of Concordia, Entre Ríos Province (Ministerio de Cultura y Comunicación, 2015). Woody residues previously burned on site at sawmills are now used to make wood pellets, a renewable energy source. However, little research has explored how local people perceive the socioecological effects of tree plantation expansion in the region

(Diaz et al., 2015; Paruelo, 2012; Vihervaara et al., 2012), an important consideration as global demand increases for renewable sources of energy and wood products in general.

Recent studies suggest destabilized land tenure situations, restricted land accessibility through land acquisitions (Gerber, 2011), land concentration and socioeconomic decline (Charnley, 2005), insecure jobs, dangerous working conditions (Bardomás, 2007), links to increasing poverty and other negative socioeconomic consequences of tree plantation establishments (Andersson et al., 2015). Charnley (2005) points out that the large upfront costs associated with tree plantations as well as slow economic returns make plantation investments better suited for large-scale operations, creating difficulties for small landowners to become involved in the industry. Other studies point out ecological consequences including negative impacts on soil fertility, water regulation, and biodiversity (Bremer and Farley, 2010; Jobbágy and Jackson, 2004). At the same time, others suggest that tree plantations could be beneficial, providing economic benefits, climate, flood, and erosion regulation, and removing pressure on native forests, depending on where tree plantations are established (Jobbágy et al., 2012; Wright and Gaitan, 2000). Few studies have explored people's perceptions of these possible benefits and drawbacks to tree plantations in the region (Diaz et al., 2015; Paruelo, 2012; Vihervaara et al., 2012).

This research generally focuses on how community members in Argentina perceive the effects of tree plantations on their communities and the environment. We approached this investigation using a mixed method comparative case study analysis between two communities located in the Entre Ríos Province of Argentina where tree plantations have expanded in recent years due to government incentives, low land prices, and favorable ecological conditions (Rubio, 2006). The communities selected are distinct in terms of the size of tree plantations and scale of forestry industry in each location, providing a means for comparing community perceptions of tree plantations in the same region. First, we examined how local people define ecosystem services and how they perceive tree plantations as affecting these services and human well-being. We then conducted a literature review to determine how land tenure and land use history shape tree plantation developments in the region. We explored how different land tenure and land use histories in our case study communities sometimes result in distinct perceptions on tree plantations.

A key theme that arose from my research was the connection between community perceptions (positive or negative) and the size of tree plantations and scale forestry industry in our case study communities. Generally, we observed more positive perceptions about tree plantations in the community with large tree plantations and a well-developed forestry industry while the opposite was true

for the community with small tree plantations and an unevolved forestry industry. At the same time, these communities shared concerns about labor force conditions on tree plantations and loss of cultural values. By exploring perceptions of tree plantations, I hope to add to the understanding of the effects of tree plantations on local communities and provide community level insight to decisionmakers for more sustainable development of tree plantations.

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Chapter 2: Defining ecosystem services and links to well-being in a shifting agricultural landscape: perceived benefits and drawbacks of tree plantations in Argentina

Abstract

The expansion of tree plantations across Argentina raises concerns about their effects on ecosystem services and human well-being. Land use conversion from pasture and other agricultural uses to plantations affects ecosystem services and consequently local people's well-being. Little research has explored the complexity of these interactions in the agricultural landscapes of Argentina as they shift from agriculture and cattle grazing to tree plantations. We used a qualitative approach in a comparative case study analysis between two Argentine communities with small and large-scale tree plantation developments to examine how community members in rural agricultural areas define ecosystem services as compared to the Millennium Ecosystem Assessment (MEA). We analyzed how people attribute importance to ecosystem services, and how they perceive effects on well-being due to changes in ecosystem services driven by tree plantation developments. Results indicate that people define ecosystem services similarly to the MEA, but descriptions are integrated, with some descriptions strongly linked to well-being. Community members described provisioning and cultural services as most important. Perceived effects of tree plantations on ecosystem services and well-being varied across communities generally with positive benefits perceived in the community with large-scale developments, and fewer benefits perceived in the community with small-scale developments. These results highlight the complexity of defining and measuring ecosystem services and the need for place-based approaches in order to better understand the effects that different scales of tree plantations have on human well-being. Such knowledge could help guide land management decisions to ensure that such developments provide benefits at both scales. Global expansion of tree plantations for timber markets and bioenergy feedstocks warrants critical examination of the sustainability of such expansions within the socioeconomic context.

Highlights

- Definitions of ecosystem services are integrated and similar to the Millennium Assessment
- Provisioning services are generally described as most important, followed by cultural services
- Perceptions of tree plantation impacts on ecosystem services and well-being vary

Keywords: ecosystem services, eucalyptus, millennium assessment, in-depth interviews, tree plantations, well-being

1. Introduction

Human well-being depends upon the provisioning of ecosystem services, and land use change can either enhance or degrade these services and the benefits they provide to people (MEA, 2005). Global demand for wood products is driving land use change through the expansion of tree plantations across Latin America (FAO, 2015a). Tree plantations cover over one million hectares in Argentina alone, and annual production from tree plantation harvests quadrupled between 1986-2013, surpassing 12 million tons extracted annually (MAGyP, 2014a, 2014b). Favorable policies encourage local and foreign investment in tree plantations across Argentina, particularly in the Pampean and northeastern regions of the country where rapid tree growth rates (35 m³/ha/year for *Eucalyptus grandis*) provide quick returns on investments (Cubbage et al., 2010, 2007) as land for traditional agricultural crops and cattle ranching are converted to plantations.

Eucalypts, species *E. globulus*, were initially introduced in Argentina in 1857 for use as windbreaks and decorative vegetation (INTA, 1995; Sánchez Acosta and Sepliarsky, 2005; Sánchez Acosta, 1999). The first industrialized eucalypt plantations in Argentina were developed in the Misiones and Entre Ríos Provinces in the 1940s (INTA, 1995). By the early 1990s, over 50,000 hectares of *E. grandis* were planted in the Entre Ríos Department of Concordia compared to fewer than 10,000 hectares planted in the entire Misiones Province (INTA, 1995). Most recent information on total area dedicated to tree plantations (includes conifers, eucalypts, willows, and others) shows Corrientes Province with the most hectares planted in the country (over 373,000 hectares) followed by Misiones (over 350,000) and Entre Ríos (154,000) (MAGyP, 2014a). Faster tree growth rates in the Corrientes and Misiones Provinces and longer histories of forestry industry linked to harvesting of native forests in these provinces contribute to their majority share of the country's area dedicated to tree plantations.

Argentine forestry policies incentivize domestic and foreign investment in plantation forestry through tax breaks and direct subsidies (MAGyP, 1999; Sánchez Acosta, 1999). Law N° 25080, implemented in 1999 and extended with Law N° 26432 in 2008, provides direct incentives for investment in plantation forestry. Species planted include native and non-native species, although non-native pine and eucalyptus species account for 59% and 21% for a total of 80% of species planted under Law N° 25080 (MAGyP, 2010). The Argentine government passed Law N° 25080, or the Plantation Investment Law, to increase domestic wood supply through the introduction of new forests, and provide benefits to new and existing industrial forest projects (MAGyP, 2008). The

Plantation Investment Law was developed in response to a national dependence on paper and wood imports.

Law N° 25080 covers up to eighty percent of the cost of establishment annually for every 1-300 hectares of land developed for tree plantations (MAGyP, 1999). Up to twenty percent of the cost of establishment is covered annually for every 301-500 hectares developed (MAGyP, 1999). Additional tax benefits under Law N° 25080 include tax breaks, tax stability, and accelerated depreciation on capital goods necessary to manage plantations (MAGyP, 1999). Between 2003 and 2015 the number of hectares dedicated to tree plantations increased nearly nine fold in Entre Ríos under Law N° 25080 (Fig. 1).

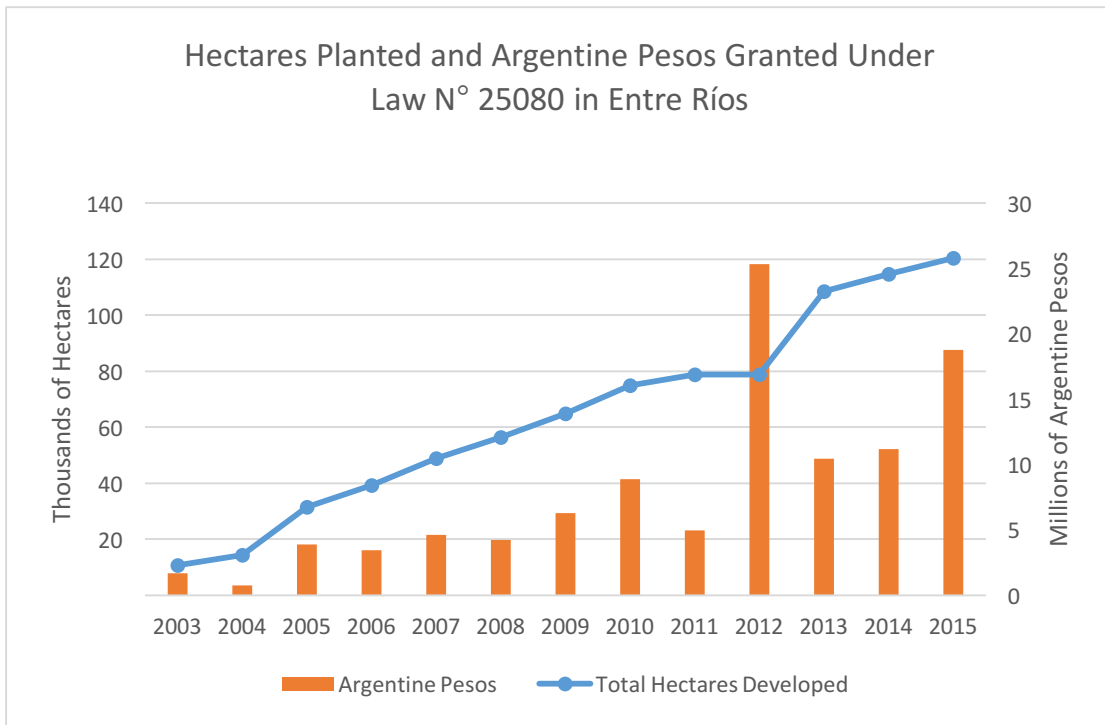


Figure 1. Hectares planted and Argentine Pesos granted under Law N° 25080 in Entre Ríos Province (MAGyP, 2015b). Note: Total hectares developed excludes tree plantations established outside of provisions under Law N° 25080.

The forestry sector in Argentina is steadily expanding due to land quality, low prices for land compared to neighboring countries, and investments made in plantation forestry under Law N° 25080 (Rubio, 2006). The area of land occupied by tree plantations in Entre Ríos Province doubled between the early 1980s and 2008, accounting for over 13% of the national total by 2014 (INTA, 2009; MAGyP, 2014a). As the availability of biomass resources from tree plantations increases (Table 1), the Argentine government identified the potential of these biomass resources in helping meet national renewable energy goals (Secretaría de Energía, 2009).

Table 1

Biomass from tree plantations in Argentina in millions of dry tons

	Year	1990	2000	2005	2010
Aboveground biomass		232	325	354	358
Belowground biomass		56	78	85	86
Deadwood		n/a	n/a	n/a	n/a
Total		288	403	439	444

FRA: Forest Resources Assessment

(FAO, 2015b)

The national goal under Law N° 26190, known as the National Support for the Use of Renewable Energy Sources, aims to generate eight percent of the total national electricity consumption from renewables by 2016 (Gobierno de Argentina, 2007). Despite these policy goals, one study indicated just two percent renewable energy participation nationwide in 2014, or six percent less than the 2016 goal under Law N° 26190 (KPMG, 2014; Sánchez Rangel, 2015). Critics suggest institutional and regulatory weakness along with lack of funding and investment as drivers of this low figure. Lawmakers have responded by modifying the law, extending the eight percent target deadline to 2017, giving industries an extra year to develop renewable energy projects (Sánchez Rangel, 2015).

Biomass energy resources were identified in 2013 when the Ministry of Agriculture, Livestock and Fish (MAGyP) and the Ministry of Federal Planning, Public Investment and Services (MINPLAN) launched PROBIOMASA (Project for the Promotion of Energy from Biomass) with assistance from the United Nations Food and Agriculture Organization (Jimeno, 2014). The goal of PROBIOMASA is to advance the management, production, and sustainable use of biomass energy resources. Using results from a modeling tool known as WISDOM (Woodfuel Integrated Supply/Demand Overview Mapping), PROBIOMASA provides institutional support to carry out biomass energy projects. Waste products from industrial forestry projects were identified as a potential source for bioenergy feedstocks (FAO, 2009). Notable potential project locations using such forestry waste products are in the northeastern provinces of Entre Ríos, Corrientes, and Misiones.

The Entre Ríos Province lies in the Pampas region of Argentina, an area known historically for its substantial contribution to the country's agricultural sector (Fonseca et al., 2013). European settlers began cultivating both annual and perennial crops and raising cattle for beef and milk production at the turn of the 19th century. By the 1950s, industrial tree plantations began replacing some of these traditional land uses to supply a country-wide shortage of wood pulp

needed for making newspapers among other products, such as pallets for the growing citrus industry (INTA, 2012). Further expansion of tree plantations occurred after unfavorable economic policies, a shrinking national market, and climatic disasters brought many citrus producers close to bankruptcy in the 1990s (Aparicio et al., 2008; Bermani et al., 2005). Citrus producers had to sell or diversify their landholdings in order to minimize potential economic downturns. Noted for its lack of trees by explorers throughout time, tree plantations represent one of the more visible changes to the Pampean landscape (Jobbágy and Jackson, 2003). People's strong ties to the land associated with the agricultural history in Entre Ríos could influence their perceptions of tree plantation developments throughout time in this region.

The expansion of tree plantations across Latin America and the increasing interest in their use for biomass energy raises the question about their effects on ecosystem services and human well-being. A growing body of literature has explored the potential ecological consequences of grassland conversions to tree plantations, including high water consumption, soil acidification, and decreasing biodiversity (Bremer and Farley, 2010; Delgado et al., 2006; Farley et al., 2005; Gautreau, 2014; Jobbágy et al., 2012; Jobbágy and Jackson, 2004; Perez Arrarte, 2007). Others have explored socioeconomic outcomes of tree plantation expansions noting potential economic benefits, but also highlighting major concerns with regards to land concentration, job insecurity, inadequate wages, and dangerous working conditions on tree plantations and within the forestry industry (Andersson et al., 2015; Bardomás, 2007; Carámbula and Piñeiro, 2006; Cárcamo, 2007; Cossalter and Pye-Smith, 2003; Gautreau, 2014; Lang, 2008).

Little research has investigated the social perceptions of tree plantation effects on well-being and ecosystem services in the region (Paruelo, 2012; Vihervaara et al., 2012), and especially in Argentina (Diaz et al., 2015; Gautreau, 2014). In a study examining people's attitudes towards tree plantations in several Departments in the Entre Ríos Province of Argentina, Diaz et al. (2015) found that people with negative attitudes towards tree plantations also express greater environmental concern than people with positive attitudes, measured using the New Ecological Paradigm scale, a survey-based metric. Further, the general public expressed greater environmental concern than tree plantation owners, and attitudes towards tree plantations differed between departments. This research aims to contribute to a deeper understanding of the ecosystem service and well-being implications of this pattern of land use change through a comparative case study between two communities in Entre Ríos.

1.1 The Millennium Ecosystem Assessment: a framework for understanding

The Millennium Ecosystem Assessment (MEA) emerged in 2005 as a framework for natural resource managers and policymakers alike to explore and better understand the provisioning of ecosystem services from a landscape and their contributions to human well-being. The MEA defines four categories of ecosystem services (cultural, provisioning, regulating, and supporting) each giving light to the different ways by which the environment supports human well-being. In theory, analysis using the ecosystem services (ES) approach provides actors with a means for decisionmaking by quantifying the value of services often otherwise ignored (i.e., cultural services). However, in practice economic valuation of provisioning services (e.g., food and water) usually takes precedence over the abstract valuation of cultural services in final management decisions, despite evidence that cultural services are highly valued by society as a whole (Zagarola et al., 2014). Kosoy and Corbera (2010) criticize popular Payment for Ecosystem Services schemes developed under the ES approach that create “invisible complexity” and “invisible value” of ecosystem services through itemization and assigning single-exchange values. In addition, ES studies often focus on descriptive ecological accounts while placing less focus on locally adapted knowledge through stakeholder participation (Mastrangelo et al., 2015).

Such drawbacks to the ES approach highlight the need for place-based classifications and emphasis on community-based perspectives to better understand land use change effects on ecosystem services and human well-being. Place-based assessments are characterized as temporally sensitive evaluations of bundled ecosystem services across socially relevant units, giving attention to past change and future visions (Potschin and Haines-Young, 2012). Asah et al. (2012) used a place-based assessment to understand how people identify and define the benefits they receive from the environment, and found that people “muddled” MEA categories and identified all cultural and most provisioning services in their descriptions, a possible indication of their values. Place-based assessments involving local residents are necessary for understanding and addressing local perceptions, needs, and values in land management decisions (Asah et al., 2012). The Entre Ríos Province of Argentina provides an ideal location for such a place-based assessment on people’s perceptions of the effects of tree plantation expansion on the environment and their communities.

1.2 Tree plantation residues contribution to bioenergy

While Argentine plantations have primarily contributed to low value timber and pulp markets, recent global demand for biofuels creates space for utilizing previously underexploited byproducts of tree plantation harvests in

Argentina. The first large-scale use of these byproducts in the country began in early 2015 with the installment of a locally-owned pellet plant in the city of Concordia, Entre Ríos (Ministerio de Cultura y Comunicación, 2015; Prensa Concordia, 2013). Industrial forestry residues bought from sawmills within an 80-kilometer radius provide material for an average annual production of 75,000 tons with approximately 80% of the pellets produced exported to Spain and the remaining 20% used locally (Ministerio de Cultura y Comunicación, 2015; Prensa Concordia, 2013). While pellet production using forestry industrial residues is still at a novel stage of development overall in Argentina, national and global interest in renewable energy could spark an increase in pellet production manufacturing.

The broader renewable energy targets outlined in the National Support for the Use of Renewable Energy Sources Law (Law N° 26190) support the growing Argentine forestry industry. While the Plantation Investment Law (Law N° 25080) promotes the expansion of tree plantations, Law N° 26190 encourages pellet production using forestry byproducts. The WISDOM model calculates over 160,000 dry tons of potential biomass resources from sawmill residues in the Entre Ríos Province (FAO, 2009). In the Department of Concordia, forestry industrial residues have a generation potential of 25 megawatts (Secretaría de Energía, 2009). Countrywide, the Food and Agriculture Organization reported 444 million dry tons of biomass available from cultivated forests (Table 1). Growing local and global interest in renewable energy raises the question about effects of tree plantations on human well-being and ecosystem services in general, especially considering their potential role as a renewable bioenergy feedstock.

This work aims to elicit people's perceptions of tree plantation and forestry industry effects on ecosystem services and human well-being. First, we explore how community members perceive the benefits they receive from the environment by comparing results to the MEA ecosystem services classification. We next analyze how people attribute importance to these services. Finally, we examine how people perceive effects of tree plantations and forestry developments on ecosystem services and well-being. We suggest further research to further explore links between people's perceptions and scientific studies. Results can provide policymakers with the community insights necessary to build policies and incentive programs that highlight sustainability in order to meet the needs of the community while simultaneously guiding mindful environmental regulation.

A sub-goal of this work is to contribute to what Carpenter et al. (2009) refer to as the need for “place-based, comparative, long-term research” to provide key insights about the sustainability of bioenergy developments across

the Americas. This work focuses on tree plantations, but combined with studies on other emerging woody-based bioenergy projects across the Americas, this work can be used to develop baseline conditions and draw contrasts and comparisons that provide better data for decisionmaking.

2. Methods

2.1 Study sites

Our study area is in the Entre Ríos Province of Argentina within the bordering Departments of Colón and Concordia (Fig. 2). The Entre Ríos Province lies in the northeast region of the country bordered by the Provinces of Corrientes, Santa Fe, and Buenos Aires to the north, west, and south, and the country of Uruguay to the east. Entre Ríos means “between rivers” referring to the Paraná River to the west and south, and the Uruguay River and the Mocoretá River to the east, and the Guayquiraró River to the north. This region is referred to as the Mesopotamic Campos, a subtropical savanna representing the northern expression of the Pampas region with a temperate climate and mild winters (Garbulsky and Deregibus, 2006; Krapovickas and Di Giacomo, 1998). Super-humid environments in the Campos region produce evenly distributed rainfall averaging 1200 mm annually (Garbulsky and Deregibus, 2006). The Campos region naturally comprises a native grassland ecosystem dominated by an assortment of genera such as *Andropogon*, *Aristida*, *Briza*, *Eriantbus*, *Piptochaetium*, *Poa*, *Stipa*, *Paspalum*, and *Panicum* (Krapovickas and Di Giacomo, 1998). Native tree species including *Prosopis nigra*, *Aspidosperma quebracho-blanco*, and *Hexachlamys edulis* exist in isolated patches or within riparian forests (Krapovickas and Di Giacomo, 1998; Pérez Piedrabuena and Bentancur Viglione, 2013). Dwarf palms of the genera *Alagoptera*, *Syagrus*, and *Diplothemium* grow together mixed with grasses in some areas, and *Syagrus yatay* form open woodlands in other areas (Krapovickas and Di Giacomo, 1998).

The Pampas grasslands became a key natural resource for cattle ranchers and agricultural producers during the late 18th and early 19th centuries (Fonseca et al., 2013). Cattle ranching created a common cultural identity in the Pampas region (Fonseca et al., 2013). The Pampas transformed into the most dynamic and economically important region of agricultural production into the twentieth century (Fonseca et al., 2013). Opportunity in Argentina drove a wave of Spanish and Italian immigration which brought changes in the social makeup of the country along with settlement in agricultural colonies across the Pampas (Garbulsky and Deregibus, 2006). Currently the Pampas region is dominated by soy, wheat, and corn production as well as cattle ranching (Fonseca et al., 2013;

Schnepf et al., 2001). Higher profits for cash crops increased local interest in cash crop cultivation and resulted in a decrease in cattle ranching in the region (Schnepf et al., 2001). Modern no-tillage techniques and genetically modified soybeans reduced the need for pastures and cash crop rotations previously required in order to maintain soil fertility (Garbulsky and Deregibus, 2006).

We selected two communities with different sizes of tree plantations and scales of involvement in the forestry industry for comparing perceived effects of eucalyptus plantation developments on ecosystem services and well-being (Table 2). Our reference community for large-scale forestry industry and large tree plantations was Ubajay in the Department of Colón, known regionally as the “wood capital”. La Criolla, in the neighboring Department of Concordia, was selected to represent a community in transition from a citrus-dominated landscape and economy to that of a more diversified economy that includes small tree plantations and some involvement in the forestry industry. By selecting two study sites we provide context in a region where tree plantation developments vary in their level of development, expansion, and type of land use conversion.

(Methods continue on Page 17 following Figure 2 and Table 2)

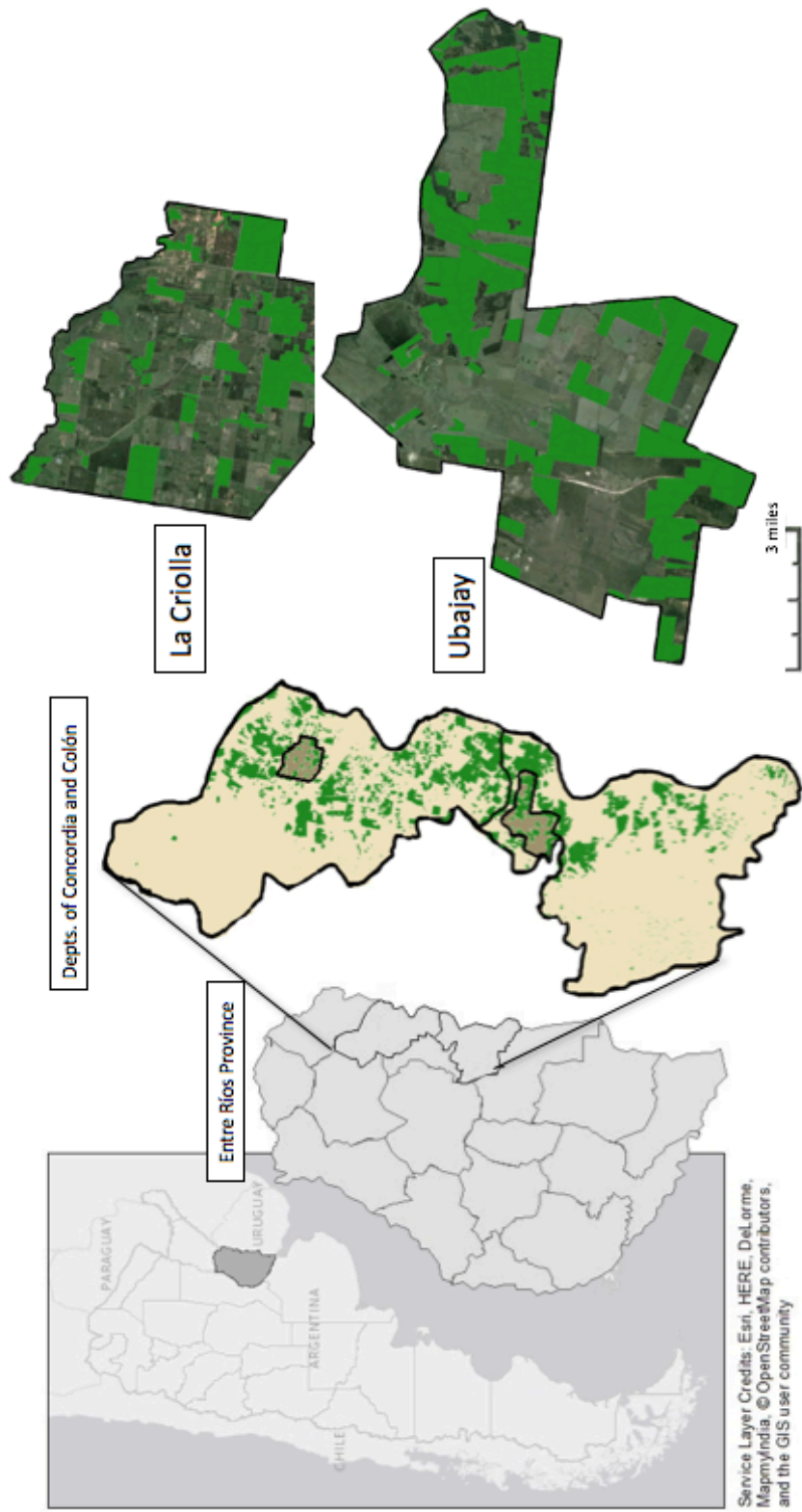


Figure 2. Study sites of La Criolla and Ubajay within the Departments of Concordia and Colón in the Entre Ríos Province of Argentina. Green areas show tree plantations. Three-mile scale refers the communities of Ubajay and La Criolla (Map created using data from the Forest Plantation Map made available online by SIIA [Sistema Integrado de Información Agropecuaria] under the Ministry of Agroindustry’s Direction of Forestry Production).

Table 2
Comparative case study community descriptions

Variables	Ubajay	La Criolla
Department	Colón	Concordia
Year founded	1915	1930
Current land uses	Plantation forestry, other (aviculture, beekeeping, cattle grazing, rice, sorghum, soy)	Citrus, blueberry, plantation forestry, other (aviculture, beekeeping, cattle grazing, pecan)
Historical land uses	Agricultural production (e.g., wheat, rice, corn, flax, canary seed, barley, sorghum, sunflower), aviculture, and cattle grazing	Citrus, other (viculture, olive production, cattle, rice)
General landholding sizes	Large	Small to medium
Average patch size (hectares)	34.6	15.7
2001 Population	2,334	1,852
2010 Population	3,507	2,382
Percent change in population (2001-2010)	+50.26%	+28.62%
Forestry industry	<ul style="list-style-type: none"> • 9 sawmills within municipal boundaries (9 others within 30 km, totaling 18) • 1 nursery (largest in Entre Ríos) • 70% population receiving direct income from forestry industry 	<ul style="list-style-type: none"> • 1 sawmill • 2 pressure treatment plants
Unemployment rate (departmental level) (2010)	3.67%	4.59%
Housing conditions (2001)		
Excellent	45%	36%
Good	26%	32%
Poor	13%	23%
Very Poor	17%	9%

Source for forestry industry data for Ubajay: (Gobierno de la Provincia de Entre Ríos Consejo Federal de Inversiones, 2009); Source for forestry industry data for La Criolla: Respondent interview data

Average patch size determined through remote sensing analysis of Landsat8 images. The word “patch” refers to delineations of different land uses (including citriculture, cropland, espinal, rangeland, and tree plantations)

Data for population, unemployment rate, and housing conditions obtained from the 2001 and 2010 National Population Censuses of Argentina.

Housing conditions provide one means for understanding the socioeconomic conditions of communities in Argentina. These figures are determined through National Population Census data referred to as CALMAT (Quality of Building Materials Used for Housing).

2.2 Sample selection

We used a categorical and snowball sampling technique to identify a subgroup of the population in each community based on descriptive community roles (Table 3). Categorical sampling was used to select community-role specific participants identified through snowball sampling. Selection of participants based on community role is important because the relationships of individuals to the forestry industry is likely to affect context-dependent ES perceptions which must be differentiated to avoid bias (Paruelo, 2012). Community roles identified participants as land producers or non-land producers with 11 descriptive roles for non-land producers (Table 3). We tracked demographic characteristics of participants (gender, age, and general income class), narrowing the discriminative component of our sampling technique to obtain representativeness as necessary and possible.

2.3 Community entry, local participation, and pilot interviews

We conducted windshield surveys followed by at least two site visits to obtain descriptive knowledge of each community. Site visits involved visiting the municipality to meet community leaders, introduce our project, and seek community acceptance. We also visited local museums, libraries, and businesses to familiarize ourselves with the communities and community members. We accepted invitations to radio interviews (two in Ubajay, one in Concordia), which helped facilitate connections and sampling as these radio interviews built trust within these small communities. Two pilot interviews were conducted in Ubajay during the third week of the field season in May 2014. Conducting pilot interviews allowed for revision of the interview protocol for clarity and conciseness. The pilot interviews also allowed our team of researchers to become familiar with the interview process within the context of Entre Ríos.

2.4 In-depth, qualitative interviews

In-depth, qualitative interviews allow interview respondents to reflect and discuss major themes and topics in detail through personal accounts and storytelling (Seidman, 2013). These produce high quality data that is essential for conducting place-based assessments aimed at understanding perceptions of benefits received from the environment (i.e., ecosystem services). We conducted in-depth, qualitative interviews in Spanish during May through July 2014. Interviews were conducted in person and recorded, lasting between 30 minutes and 3 hours. Graduate students from Northern Arizona University and the State University of New York conducted interviews with assistance from undergraduates and a recent graduate from Universidad Nacional de Entre Ríos in Concordia, Entre Ríos. Interviews were conducted in teams to ensure the

safety of the interviewers while simultaneously providing for more robust data collection (i.e., one person conducted the interview while another person took notes). Support from local professionals provided a means for addressing potential language barriers and gave non-Argentine researchers a chance to better understand the culture, linguistics, and history of the region.

All interviewers completed the Collaborative Institutional Training Initiative (CITI) program prior to conducting interviews. CITI training provides researchers with up-to-date information on human subjects protection and Responsible Conduct of Research issues. The University of Oregon's Institutional Review Board reviewed and approved the interview protocol, and we sought verbal consent before commencement of each interview (Attachments 1 and 2). The interview questionnaire included a series of 39 questions of which a subset was used for analysis in this study (Attachments 3 and 4). These questions included references to the following: general community structure (e.g., How would you describe your community? What do you like about your community?); ecosystem services (e.g., What do you like about the environment? What benefits do you receive from the environment? Have you noticed these benefits change through time? If so, how and why?); and the forestry industry (e.g., Has the development of tree plantations and the eucalyptus industry in this region positively or negatively impacted your community or the environment? If so, how?). Questions about community characteristics and structure were asked to triangulate understanding of well-being and perceived direct and indirect drivers of change to well-being. Tree plantations and eucalyptus industry questions were used to elicit perceptions of their effects on well-being and ecosystem services (i.e., benefits received from the environment).

2.5 Data analysis

All interviews were recorded and then transcribed for analysis. We used QSR International's NVivo 10 Software to analyze interview response data through systematic theming and categorization in Spanish. Preliminary themes were developed based on field notes and listening to the interviews while transcribing. These initial themes were modified through the iterative process of coding and querying the data (Miles et al., 2014). We used the Millennium Ecosystem Assessment (MEA) categories and subcategories of ecosystem services as a framework for deductively coding respondent descriptions and definitions of ecosystem services (Asah et al., 2012). We then used inductive analysis and coding guided by the grounded theory approach to sort ideas that fell outside of our deductive analytic process (Asah et al., 2012; Glaser and Strauss, 1967). These ideas were organized and then reorganized through inductive analysis to reveal respondents' perceptions of the benefits they receive from the environment (Asah et al., 2012). The MEA categories and descriptions

for well-being served as an initial guide for coding data relevant to well-being. We used the same approach of deductive followed by inductive analysis for studying respondents' perceptions of well-being.

In addition to exploring how respondents described and defined ecosystem services, we measured importance placed on ecosystem services in two ways. First, we examined expressed importance through analysis of ecosystem services described by respondents when asked, "Which benefits from the environment are most important to you?" We explored which ecosystem service subcategories were identified as important and how often (i.e., number of interviews during which each ecosystem service was described as most important). The second method we used for measuring importance was through coding interpretation. We used the frequency with which ecosystem service subcategories were mentioned within the data set analyzed as a measure of importance. Exploring importance using two different methods allowed us to better understand the relevance of those ecosystem services most mentioned to those that respondents expressed as most important.

3. Results

3.1 In-depth interview respondents

A total of 66 individuals (36 men and 30 women) participated in 58 interviews, with 29 interviews held in each of our two communities (Table 3). Respondents ranged in age and general income class with more young people interviewed in Ubajay. This figure sheds light on the importance of the forestry industry in Ubajay, which demands a workforce generally comprised of young males who often immigrate to the area from neighboring provinces and countries for plantation and sawmill jobs. Those interviewed included nine land producers in Ubajay and 15 in La Criolla who combined represented 18 different landholdings. Landholdings were all 100 hectares or less in size in La Criolla whereas over half of landholdings were 201 or more hectares in size in Ubajay.

(Results continue on Page 20 after Table 3)

Table 3

Demographic characteristics of case study communities

Variables		Ubajay	La Criolla	Totals
Respondents		31	35	66
Gender	Male	52%	57%	55%
	Female	48%	43%	45%
Age Categories	18-30	29%	0%	14%
	31-40	19%	20%	20%
	41-50	16%	31%	24%
	51-60	16%	23%	20%
	61-70	13%	17%	15%
	71+	6%	9%	8%
General Income Class ^a	Low	21%	10%	16%
	Low-Medium	17%	3%	10%
	Medium	41%	45%	43%
	Medium-High	3%	14%	9%
	High	17%	28%	22%
Community Role				
Non-Producer ^b		68%	57%	62%
Land Producer		32%	43%	38%
Landholding Size (ha)	0-100	43%	100%	83%
	101-200	0%	0%	0%
	201-300	14%	0%	6%
	301+	43%	0%	17%

^aIncome class determined by vehicle ownership. Classification is as follows: Low= No vehicle; Low-Medium= Motorcycle; Medium= Sedan; Medium-High= Truck; High= Owns multiple vehicles

^bIncludes 11 descriptive roles: community leader, culture, education, elder, general, health, history, landworker, local business, newcomer, other worker
General Income Class and Landholding Size percentages are based off the number of interviews rather than the number of respondents. This was done so as to not double count these figures for the same household where in some cases we interviewed no more than two family members.

3.2 MEA comparisons and novel descriptions of ecosystem services

Respondents described the benefits they receive from the environment from all four MEA categories with the majority of respondents identifying one or more of each provisioning and cultural services (Tables 4-7). Regulating and supporting services were less frequently discussed, with fewer than half of

respondents describing supporting services. A subset of the MEA-defined ecosystem services were left undescribed by respondents, including more than half of the MEA-defined supporting services (Tables 5 and 7).

Not all descriptions of benefits from the environment fell within the MEA defined categories of ES. Respondents described benefits in novel ways, perceiving benefits as integrated or interrelated rather than as isolated individual services. The following quote illustrates a respondent's integrated interpretation of two subcategories of cultural services, aesthetic values, and sense of place:

“I think that the people who come from out of town, from the big city, to communities like our own can tell the difference, they feel the silence, and they appreciate it because in the city silence does not exist because when the day begins [in the city] so does the noise pollution, but here in the community when you're outside you hear the silence, you hear the wind, the birds, the bees...”

Here the respondent describes the aesthetic values of their community that create a sense of place and distinguish it from big cities.

In addition to interrelating MEA categories of ecosystem services, we found that respondents integrated MEA indicators of well-being into their descriptions of benefits from the environment. The MEA frames human well-being as dependent upon the provisioning of ecosystem services, but respondents did not necessarily distinguish between MEA indicators of well-being and the benefits they receive from the environment. Health benefits emerged in this sense as reflected in these respondents' descriptions of air quality regulation, disease regulation, and recreation as linked to human health, an MEA indicator of well-being:

“In reality the issue of...maintaining an environment with a certain purity, free of smoke, free of smog, free of noises...harmful to health...keeps us healthier, physically and mentally”

“...the environment is important for good health and for everything, for maintaining good health...”

“[The environment is important] for good health...people go out walking a lot...in the afternoons...”

This illustrates peoples' recognition of the strong link between the provisioning of ecosystem services and human well-being. Similarly, when asked, “What benefits do you obtain from the environment?” nearly half of respondents described the economic benefits they receive from the environment, suggesting an integrated interpretation of the MEA categorization of provisioning services

with another MEA indicator of well-being (i.e., basic materials for a good life). This quote illustrates this integration:

“Obviously...the main benefit we have is from the earth and it’s economic...it’s having jobs...in other words...we survive off it...and it’s thanks to the surroundings...that are tree plantations”

Respondents in the citrus-dominated community of La Criolla described pollinating services and climate regulation as important for supporting their livelihoods (e.g. well-being). The following quotes illustrate these integrated descriptions:

“...imagine that without bees there would not be pollination, in fact, there would be no fertilization of fruit and so we would enter into a complicated scenario...” [Respondent in La Criolla]

“The climate [is important] because the whole region depends on the climate” [Respondent in La Criolla]

Important to note is that respondents’ reference to pollinating services does not necessarily imply the value of native pollinators, but simply refers to the need for general pollinators to support people’s livelihoods in the region. Integrated interpretations occurred across a wide range of ecosystem services and all five MEA indicators of well-being, with basic materials for a good life most frequently integrated.

3.3 Attributing importance to ES

We examined importance by means of: 1) expressed importance (i.e., analysis of responses to the question, “Which benefits from the environment are most important to you?”); and 2) coding interpretation (i.e., analysis of the frequency with which respondents described different ecosystem services subcategories).

When asked which benefits from the environment were most important, respondents overwhelmingly chose provisioning services, with fresh air, economic benefits, and health benefits identified as most important within this category (Tables 4 and 8). Cultural services followed, with aesthetic values identified as most important within this category (Tables 5 and 8). A subset of respondents did not single out individual ecosystem services as most important, but instead explained the importance of all benefits provided by the environment (Table 8).

Overall, provisioning services were most frequently coded and identified by the most respondents, with cultural, regulating, and supporting services

following, respectively (Table 8). However, more respondents identified and more frequently mentioned aesthetic values than any other subcategory, followed by fresh air (Tables 4 and 5). Respondents also often highlighted the importance of sense of place, economic benefits, fresh water, and soil fertility and quality (Tables 4, 5, and 7).

(Results continue on Page 29 after Tables 4-8)

Table 4
Provisioning services identified across all respondents

ES Category	Expressed importance	Rank	Count	References	Subcategory	Respondent description
Provisioning services	Y (8)	2	36	75	<i>Fresh air</i>	"The benefit is that...we breathe clean air"
	Y (5)	3	27	40	<i>Economic benefits</i>	"...basically...the entire community depends...sustains itself on ecological systems..."
	Y (4)	4	23	36	Fresh water	"...what saves us...in this zone is water...you can get water from a well that's just a few meters deep...water is everything"
	Y (3)	4	21	26	Food	"...being able to get...what we obtain from the environment such as fruits, vegetables, or even different kinds of meat...is very beneficial for our nutrition because we get it directly from nature..."
	Y (5)	4	12	18	<i>Health benefits</i>	"...well, fundamentally the health benefits provided [by the environment]"
	N	5	11	15	<i>Native plants and animals</i>	"...the native fauna [here] is wonderful and beautiful, especially with regards to birds..."
	N	5	7	10	Wood products	"...it's what gives life to Ubajay because...if we didn't have the primary product which is wood, we would not have sawmills which are...the main source of work here in Ubajay"
	N	5	4	5	Genetic resources	"...work in genetics is growing...we work with clones...which undoubtedly...greatly improve the quality [of eucalyptus]..."
	N	5	1	1	Ornamental resources	"the people seek to beautify their homes...with many [plant] species"
	N	5	1	1	Biochemicals, natural medicines, and pharmaceuticals	"...it's used medicinally...it opens your bronchial [tubes]...the vapor. You put a branch of eucalyptus in a pot, let it boil, and you breathe the vapor and can drink it to use medicinally..."

Adapted from the Millennium Ecosystem Assessment (2005) categorization of ecosystem services

Subcategories denoted in italics are novel ecosystem service descriptions not described in the Millennium Ecosystem Assessment
Expressed importance determined as "Yes mentioned" (Y) or "Not mentioned" (N); the number in parentheses indicates the total count of interviews during which the ecosystem service was mentioned as "most important"

Ranks 1-5 represent coding interpretation, determined by counts of interviews during which ecosystem services were identified (1= 48-58; 2= 36-47; 3= 24-35; 4= 12-23; 5= 1-11); Ecosystem services not described do not receive a rank

Counts represent coding interpretation and refer to the number of interviews during which ecosystem services were identified (n=58)

References refer to the total number of times an ecosystem service was mentioned (i.e., coding interpretation)

Table 5
Cultural services identified across all respondents

ES Category	Expressed importance	Rank	Count	References	Subcategory	Respondent description
Cultural services	Y (4)	1	52	118	Aesthetic values	"...I like the landscape because of the different tones of green that it has. Entre Ríos is a province with many tones of green...it's a palette of colors, a painter's palette"
	N	3	25	43	Sense of place	"Every time outsiders come to visit our community they fall in love [with it] because there is...good human quality, there is a clean environment...they leave very satisfied and, in fact, they leave thinking about coming back...and here we guarantee that you are always going to know your neighbor..."
	Y (1)	4	16	25	Recreation and ecotourism	"It fills me with joy to look out at the horizon during the sunset and drink mate while watching it"
	N	4	14	17	Cultural heritage values	"And it [the environment] is important...because it represents us in terms of who we are, where we come from, and where Ubajay was born"
	N	5	4	4	Social relations	"...here I like everything...the entire region and also the people; everyone knows each other and has known each other for years..."
	Y (1)	5	3	3	Educational values	"...the learning you get from the diversity of nature itself..."
	N	5	1	1	Spiritual and religious values	"...the psychic and spiritual benefits...the personal joy it [the environment] produces for me..."
	N	-	0	0	Inspiration	None described
	N	-	0	0	Knowledge systems	None described
	N	-	0	0	Cultural diversity	None described

Adapted from the Millennium Ecosystem Assessment (2005) categorization of ecosystem services
Expressed importance determined as "Yes mentioned" (Y) or "Not mentioned" (N); the number in parentheses indicates the total count of interviews during which the ecosystem service was mentioned as "most important"

Ranks 1-5 represent coding interpretation, determined by counts of interviews during which ecosystem services were identified (1= 48-58; 2= 36-47; 3= 24-35; 4= 12-23; 5= 1-11); Ecosystem services not described do not receive a rank

Counts represent coding interpretation and refer to the number of interviews during which ecosystem services were identified (n=58)

References refer to the total number of times an ecosystem service was mentioned (i.e., coding interpretation)

Table 6
Regulating services identified across all respondents

ES Category	Expressed importance	Rank	Count	References	Subcategory	Respondent description
Regulating services	N	4	15	26	Air quality regulation	"...the air pollution that comes from the city is purified by the environment..."
	Y (3)	5	11	17	Climate regulation	"...[one benefit is] the climate...nature is the wisest of all"
	N	5	9	9	Natural hazard regulation	"...tree plantations help regulate water flows by absorbing water so that flooding is avoided"
	Y (1)	5	9	15	Water regulation	"I've notice that the majority of streams here...and the water sources have begun to decrease...where there are tree plantations the streams are dry"
	N	5	6	11	Disease regulation	"...I've seen few incidences of environmental diseases [diseases linked to the environment] precisely because it's a clean environment...the incidences of very intense winters and the intensity of intensely hot summers that bring about certain seasonal sicknesses is minimal because it's a benign environment..."
	N	5	3	5	Pollination	"...I have neighbors who are beekeepers and they notice when the environment is having problems by bee behavior...when drought occurs, the bees become desperate or when there aren't flowers instead of bringing food to the hive, the beekeeper has to provide syrup, or provide food, and for this reason if we don't have a good environment there is an imbalance..."
	N	5	3	5	Erosion regulation	"...trees [are important] for erosion. This is a zone where it rains constantly...and because the soils are sandy it's important to preserve it because the rain comes and erodes the roads so it's important to have trees to preserve the soils"
	N	5	2	2	Water purification and waste treatment	"In addition it is economically beneficial for the people, for the whole community because...the water here in town...is not purified. It does not need to be. They add some chlorine but besides that the water quality is good and that's another benefit..."
	N	5	1	1	Pest regulation	"...years ago a chincho [pest] attacked the eucalyptus...and it was during a drought...and this is worrisome..."

Adapted from the Millennium Ecosystem Assessment (2005) categorization of ecosystem services

Expressed importance determined as "Yes mentioned" (Y) or "Not mentioned" (N); the number in parentheses indicates the total count of interviews during which the ecosystem service was mentioned as "most important"

Ranks 1-5 represent coding interpretation, determined by counts of interviews during which ecosystem services were identified (1= 48-58; 2= 36-47; 3= 24-35; 4= 12-23; 5= 1-11); Ecosystem services not described do not receive a rank

Counts represent coding interpretation and refer to the number of interviews during which ecosystem services were identified (n=58)

References refer to the total number of times an ecosystem service was mentioned (i.e., coding interpretation)

Table 7

Supporting services identified across all respondents

ES Category	Expressed importance	Rank	Count	References	Subcategory	Respondent description
Supporting services	Y (2)	4	21	29	<i>Soil fertility and quality</i>	"...here in this region you can grow practically anything; everything you consume can grow...these lands produce it"
	N	4	12	5	Nutrient cycling	"It's important to use less chemicals...if we don't measure what we put into the earth and soils, the soils will not be productive in the future. Many lands have been ruined...soy uses many nutrients from the soil and you have to wait many years before the soil is fertile again..."
	N	5	9	10	Photosynthesis	"...eucalyptus trees support us [people] by providing us with oxygen"
	N	-	0	0	Water cycling	None described
	N	-	0	0	Primary production	None described
	N	-	0	0	Soil formation	None described

Adapted from the Millennium Ecosystem Assessment (2005) categorization of ecosystem services

Subcategories denoted in italics are novel ecosystem service descriptions not described in the Millennium Ecosystem Assessment

Expressed importance determined as "Yes mentioned" (Y) or "Not mentioned" (N); the number in parentheses indicates the total count of interviews during which the ecosystem service was mentioned as "most important"

Ranks 1-5 represent coding interpretation, determined by counts of interviews during which ecosystem services were identified (1= 48-58; 2= 36-47; 3= 24-35; 4= 12-23; 5= 1-11); Ecosystem services not described do not receive a rank
Counts represent coding interpretation and refer to the number of interviews during which ecosystem services were identified (n=58)

References refer to the total number of times an ecosystem service was mentioned (i.e., coding interpretation)

Table 8

Measures of importance across all respondents

ES Category	Expressed importance			Coding interpretation		
	Count	%	Rank	Count	%	Rank
Provisioning	24	56%	1	56	97%	1
Cultural	7	16%	2	55	95%	2
Regulating	3	7%	3	34	59%	3
Supporting	2	5%	4	28	48%	4
Other	7	16%	2	-	-	-

Expressed importance refers to importance measured by preferences identified when asked "Which benefits from the environment are most important to you?"; Counts refer to number of interviews where ecosystem services under each category were preferred (i.e., most important); counts are equal to one response per interview (n=43 [we did not ask the question of importance in 15 interviews, hence n=43 and not 58]); Percentage refers to the fraction of these interviews where respondents preferred each ES category; "Other" refers to interviews where respondents answered "all benefits from nature are important" (i.e., all four categories of ecosystem services)

Coding interpretation refers to importance measured by coding frequencies; Counts refer to the number of interviews during which each category of ecosystem service was identified (n=58); Percentage refers to the percentage of the total number of interviews where each ES category was identified.

Rank for both "expressed importance" and "coding interpretation" is determined by the greatest number of counts for each ES category

3.4 Perceptions of eucalyptus development effects on ecosystem services and well-being

Respondents in both communities discussed the effects of tree plantation developments on ecosystem services by linking these to perceived effects on human well-being. Results are presented within the context of MEA categories as a combination of perceptions from both communities (Figure 3). Respondents described multiple pathways by which eucalyptus developments both positively and negatively affect ecosystem services and well-being (Figure 3). Perceptions differed across the communities in terms of the ecosystem services and well-being indicators described, with positive and negative perceptions expressed in both communities. Respondents described other direct and indirect drivers of change affecting ecosystem services and well-being and credited these drivers in shaping the development of tree plantations and or forestry industry in the region (Figure 3). In other words, direct and indirect drivers of change affect eucalyptus developments at the same time as they may be affecting ecosystem services and human well-being.

3.4.1 Economic benefits, security, and cultural heritage values

Respondents across these communities differed considerably in their perceptions about how tree plantations and the forestry industry affected basic materials for a good life and links to economic benefits. These differences seem to stem from the forestry industry's distinctive levels of development within each community. In Ubajay, the forestry industry is well developed. Nine sawmills are located within community boundaries, the largest tree nursery in Entre Ríos is just 15 kilometers to the south, and the landscape is dominated by large-scale eucalyptus plantations, all of which provide value-added industries and temporary and permanent work for the community. La Criolla hosts just one sawmill and two pressure treatment plants, plus fewer, smaller eucalyptus plantations. The majority of respondents in the forestry industry-dominated community of Ubajay expressed positive perceptions related to the income and employment provided by the industry and tree plantations. Contrastingly, respondents in La Criolla not only felt that the tree plantations did not provide jobs and wages, but that they displaced jobs and wages previously available on citrus plantations, many now converted to eucalyptus plantations (Figure 3). These contrasts are illustrated in the following quotes:

“...our community has changed...from very poor to...modest and it was primarily due to the sawmills...things like homes and the social quality and quality of education...have changed a lot in these past years mostly due to the boost created by the sawmills because this used to be a small town with a poor quality of life but in the past eleven years it's grown significantly” [Respondent in Ubajay]

“...today everyone invests in wood, but only three or four people actually benefit from it because [tree plantations] do not demand much labor. On the other hand, citrus provides a lot of jobs...” [Respondent in La Criolla]

Thus, most respondents expressed largely positive perceptions in Ubajay, while more people had negative perceptions in La Criolla concerning tree plantations and their linkages to economic benefits and basic materials for a good life (Figure 3). However, both positive and negative perceptions related to these factors were described in each community.

Both communities expressed concern regarding forestry industry-related labor conditions and similar indicators of well-being (e.g., security) (Figure 3). Respondents described forestry plantations as relying on cheap, black market labor often supplied by migrants from northern Argentine provinces and the Republic of Paraguay. Concerns included lack of access to health care and benefits, unsafe working conditions, and insecure jobs. The following quotes shed light on these concerns:

“...they [workers] are living in very precarious situations and now it’s gotten a lot better...today the problem is not so much in the sawmills because the sawmills provide a physical, stable place. The problem is the exploitation in the tree plantations...” [Respondent in Ubajay]

“...There is a lot of temporary work. I notice that about eighty percent of the population does not have social security because they’re not employed as registered workers...this occurs in businesses and other places like sawmills and on tree plantations...they [the workers] work and they pay them by the day” [Respondent in Ubajay]

“It’s the biggest fraud for the poor people...they come from other provinces, from Tucumán, Misiones, Corrientes...they come looking for work and they [sawmills] take them in, trick them, and the poor people work and afterwards find out they have nothing...they are exploited” [Respondent in La Criolla]

People in both communities perceived tree plantations and, to an extent, the general forestry industry, as negatively affecting security. The exception to this was in Ubajay where people had positive perceptions about the contribution of tree plantations to availability of stable jobs (Figure 3).

Respondents described a loss of traditional cultural values and aesthetic characteristics of the landscape related to the establishment of tree plantations in their communities:

“What I see is a general growth in [the number] of tree plantations...in a way it gives you a certain suspicion, or some sort of nostalgia for the things that were lost...” [Respondent in Ubajay]

“Maybe I do not really enjoy such great sections of monoculture of eucalyptus and pine because one wants to see the horizon and never can because it’s blocked by tree plantations which are artificial...I’ve seen photos of Ubajay thirty years ago and [tree plantations] did not exist...well, they existed, but not like the enormous quantity that there is today...” [Respondent in Ubajay]

“Every day we are left with less and less of what we were before. They [producers in the community] are leaving because they sold their properties and they leave... most likely they produced citrus, but they quit producing citrus, sold [their property], and now other people own the land and they plant tree plantations” [Respondent in La Criolla]

“...we as citrus producers think that planting eucalyptus is bad use of the land. In other words, it hurts, it’s sad...” [Respondent in La Criolla]

The loss of cultural values was closely linked to the diminishing citrus industry in La Criolla.

Respondents described an influx in population as migrants from northern provinces (primarily Misiones and Corrientes, but also Santiago del Estero and Chaco) move into the region seeking temporary employment on tree plantations. This was perceived as putting pressure on traditional cultural heritage values and tight knit social relations in these historically small, agricultural communities previously dominated by cattle ranching and agricultural (Ubajay) and citricultural (La Criolla) land production systems. Respondents in Ubajay emphasized the challenge of integrating and accepting cultural differences in the school systems as disparities in language (migrants from Misiones speak a blend of Portuguese and Spanish, or “portuñol”) and attire (immigrants from subtropical regions traditionally use open-toed shoes rather than close-toed) required additional resources and the immediate need for lessons on cultural acceptance. In both communities, respondents described these differences as providing the community with an opportunity to be more accepting, while others were less optimistic about the shifting cultural makeup of the community, citing a lack of enthusiasm and acceptance from local community members (Figure 3). This dynamic is described by a community member in Ubajay:

“It seems to me that the world of immigrants who are living in very precarious situations, like those from Misiones, is also a problem, but not because they come [to the community] but because of the social difference that is established...the locals sometimes see them as a threat because...they overburden the education system, the health system, but they continue being invisible and so we realize that nothing is done” [Respondent in Ubajay]

3.4.2 Regulating services and soil fertility and quality

Tree plantations were perceived positively in both communities for acting as “green lungs” that purify the air (e.g., air quality regulation). Respondents discussed this as positive for the health of the community (Figure 3). In contrast, some respondents cited negative impacts on air quality due to open air burning of forestry residues at sawmill sites. Respondents also described the negative impacts on water regulation and natural hazard regulation linked to tree plantations (Figure 3). In both Ubajay and La Criolla, respondents described the potential implications for freshwater availability due to what they described as high rates of water consumption by eucalypts observed through loss of surface and groundwater resources:

“My grandmother’s land is in front of a tree plantation. As this tree plantation began to grow, the stream began to dry up. And it’s at that point that you realize the impact it’s having [on streams]” [Respondent in Ubajay]

"Anywhere around here you could find water five meters beneath the ground...but today they say it’s difficult to find water around here, and they say it has to do with the tree plantations that are drying up the wells" [Respondent in La Criolla]

An additional concern sometimes discussed was the potential fire hazard caused by tree plantations installed near the communities.

In both communities, respondents described tree plantations as negatively affecting soil fertility and quality. Concerns included the potential non-usability of land occupied by tree plantations in the future and the high costs associated with converting tree plantations to other land use types once a tree plantation is established (i.e., cost of removing tree trunks).

3.4.3 Direct and indirect drivers of change

Respondents also described direct and indirect drivers of change as shaping tree plantation developments and simultaneously affecting ecosystem services and human well-being (Figure 3). Indirect drivers of change were mostly

discussed in the context of shaping tree plantation developments rather than as affecting ecosystem services and well-being. Global demand and government subsidy programs were described as driving the expansion of tree plantations in the region. Respondents credited swift changes in market prices for agricultural products (e.g., citrus) as negatively impacting well-being, while changes in market prices for other products (e.g., wood products) stimulated the establishment of tree plantations which provided economic benefits and increased well-being. The following quotes provide examples of these perceptions of indirect drivers that shape tree plantation developments:

“As long as [eucalyptus] continues to be profitable, people will keep planting more eucalyptus because, in addition, there is another factor at play: because there is global need [for wood products], the Argentine state has subsidized tree plantations for many years. An Argentine producer can establish a tree plantation practically for free...” [Respondent in La Criolla]

“...the benefits [we receive] have increased and have changed because ...the value of eucalyptus has changed...in addition, Argentina transformed into an important exporter of wood which made it so that all the wood industries in the nation grew, and the tree plantations, too...” [Respondent in Ubajay]

“All of the fruit that you see [out there] on our quinta [citrus plantation], on all of the trees...should not have any fruit. None. They should all be harvested...[but] we cannot export because they [the government] does not give out permits to export. And the internal market is completely marked down due to the [economic] crisis...and in reality nobody [in the internal market] eats this type of fruit...” [Respondent in La Criolla]

Direct drivers of change were described as influencing tree plantation developments, ecosystem services, and human well-being. For instance, respondents noted the need for agrochemicals in order to develop tree plantations, while also discussing their impact on the environment and human health. On the other hand, improvements in technology were mentioned as helping advance tree plantation developments and providing safer working conditions.

Finally, respondents in La Criolla highlighted the negative effects of global climate change on provisioning services such as agricultural production (i.e., economic benefits) which simultaneously had negative implications for security and basic materials for a good life such as stable jobs. The following quote illustrates this dynamic:

“...today there is nothing left, no more work...for the common worker, I mean...citrus production is in the north now, in Federación, Chajari, that whole area is now the largest region for citrus production because the climate allows for production there...here the climate has been changing...the temperatures lowered and now the [citrus] trees die...and so producers can't stay...and so you say to yourself, 'Who's going to be the fool that makes such risky investments'...” [Respondent in La Criolla]

Respondents described these climatic factors as forcing citrus production to move north, leaving the region more prone to tree plantation developments and other agricultural production systems.

(Discussion begins on Page 36 after Figure 3)

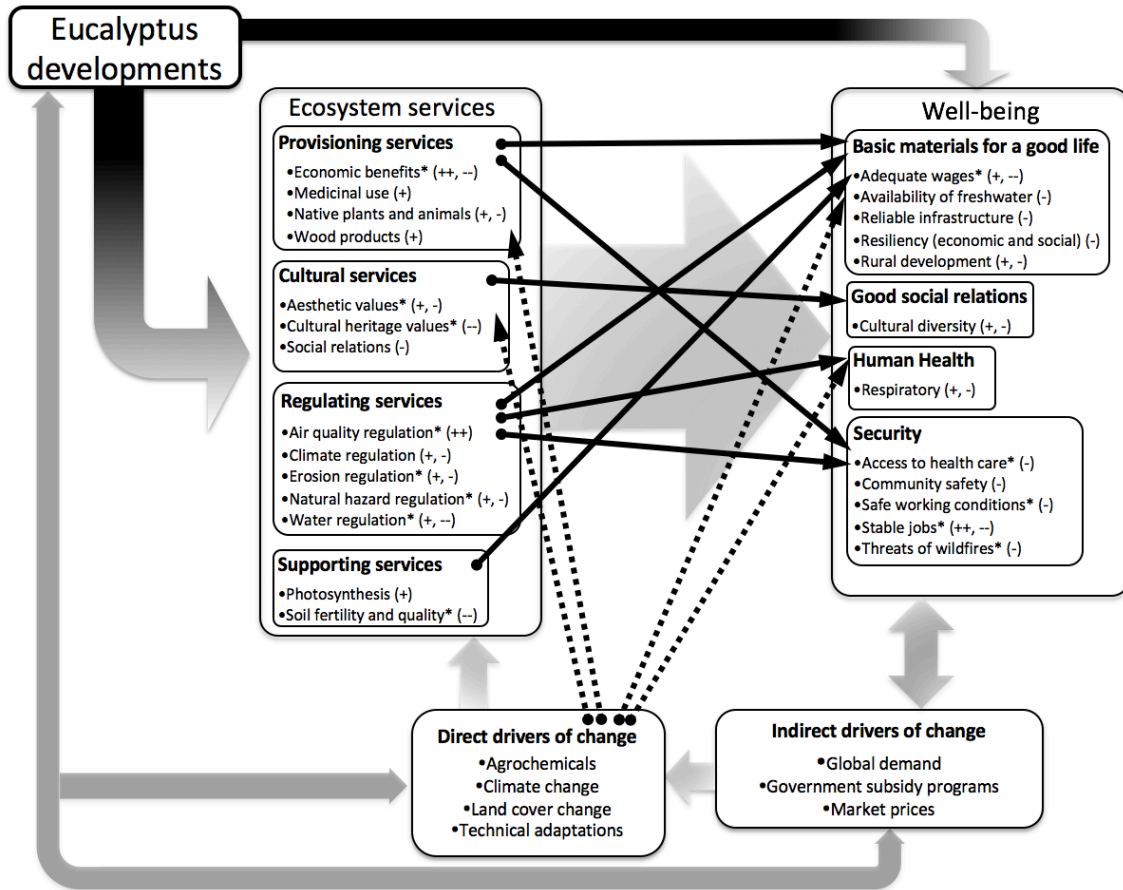


Figure 3. Interactions between eucalyptus developments, ecosystem services, well-being, and direct and indirect drivers of change as described by respondents in two communities. Plus and minus signs represent respondent perceptions (positive and negative) related to eucalyptus development effects on ecosystem services and well-being with the number of signs representing the degree of respondents' perception (i.e., more signs equaling a greater degree of the positive or negative perception).

Large black shaded arrows stemming from eucalyptus developments represent potential effects on ecosystem services and well-being. Grey arrows represent interactions and feedbacks as described by the Millennium Ecosystem Assessment. Small black arrows show perceived links between ecosystem services and well-being specific to this research. Dotted arrows represent perceptions of direct drivers of change effecting ecosystem services and human well-being specific to this study.

Asterisks indicate perceptions supported by literature.

4. Discussion

4.1 Comparing place-based ES assessments

Our place-based ecosystem service assessment is similar to work by Asah et al. (2012) who compare people's identification and definitions of benefits from local forests with the MEA. Interviewees in their study described mostly provisioning and cultural services and hardly mentioned regulating and supporting services. In addition, Asah et al. (2012) found interviewees "muddled" the MEA categories, suggesting that ordinary people might integrate ecosystem service definitions regardless of the landscape or ecosystem under study (i.e., publically managed forests in the Asah et al. (2012) study versus agricultural landscapes and communities in this study). Our findings reinforce the idea that place-based classifications of ES involving local people are needed for understanding and addressing local needs and realities in land management decisions (Asah et al., 2012; Potschin and Haines-Young, 2012). People often recognize the links between human well-being and ecosystem services (Folke et al., 2005). This is especially true for people that rely on the environment for their livelihoods, such as agriculturally based communities.

We found that a subset of MEA subcategories of ecosystem services were not identified by respondents in this study (Tables 4 and 6), including more than half of all supporting services. However, while respondents did not describe supporting services such as soil formation or primary production as defined by the MEA, respondents did identify the non-MEA described supporting benefits of soil fertility and quality of the region in general. In fact, some respondents even identified this novel supporting service as the most important benefit they receive from the environment. This parallels survey findings from Zagarola et al. (2014), who examined people's understanding of ES in Patagonia and found that supporting services were those most valued and yet least understood by survey respondents. In our study, the services identified as "most important" were often those constructed by respondents' experiences and observations rather than those services described in the MEA. This underscores the utility of locally produced assessments, which allow for deviations from predefined frameworks (i.e. the MEA) and let respondents construct their own interpretations of ecosystem benefits, better capturing how individuals understand and value ecosystem services.

The unidentified subcategories of cultural services (inspiration, knowledge systems, and cultural diversity) may reflect the linguistic and cultural challenge of identifying specific MEA subcategories of ecosystem services. This highlights the advantage of studies that use a priori methods for examining people's understanding of ecosystem services (see Zagarola et al. (2014)). In this

way, respondents are provided with a list of ES categories thus avoiding difficulties in describing services that are more complex.

The fact that provisioning and cultural services were more frequently mentioned by the most respondents and also expressed as most important may be evidence of people's values (Asah et al., 2012). Results indicate that respondents define ecosystem services similarly to the MEA definitions; however, participants did not identify some MEA services. Respondents describe other services in novel ways by interrelating multiple MEA subcategories or merging MEA ecosystem service categories with MEA indicators of well-being. Our locally produced assessment provides us with the context needed to examine the perceived effects of expanding tree plantations in this region.

4.2 Tree plantations, well-being, and ecosystem services

Land use change affects ecosystem services and their contributions to human well-being and the benefits people derive from the environment (MEA, 2005). Debates about the effects of tree plantations on ES and well-being have recently appeared in the literature (Paruelo, 2012; Vihervaara et al., 2012). Our results indicate that people perceive land use change associated with tree plantations as having both positive and negative outcomes for ecosystem services and human well-being, which are intricately related (Figure 3). These perceptions often aligned with the scale of the forestry industry and the size of tree plantation developments in the communities, with generally more positive perceptions voiced in the forestry industry-dominated community of Ubajay, which hosts multiple value-added forestry economic activities. This makes sense because the economic benefits provided by the timber industry have helped Ubajay develop and prosper through the years.

We also observed shared perceptions between the communities, with many perceived effects of tree plantations on ecosystem services and well-being supported by scientific evidence. This is expected as local people are usually aware of ecosystem services in their communities and surrounding areas (Folke et al., 2005). Some of the greatest concerns about ecosystem services discussed by respondents include loss of surface and subsurface water sources near tree plantations and soil degradation. Global and South American specific studies show that the establishment of tree plantations on non-forested areas (grasslands, croplands, shrublands) generate a decline in water yields (Farley et al., 2005; Jobbágy et al., 2012; Jobbágy and Jackson, 2004). In a study on grassland afforestation in the Pampas, Jobbágy and Jackson (2004) find increased evapotranspiration and groundwater consumption by trees causing rapid groundwater and soil salinization. While mentioning that groundwater use can enhance primary production, the authors note that expansive afforestation of

grasslands in this region could produce widespread depression of the groundwater table while compromising its replenishment at the landscape level. Respondents' concerns about water regulation (Table 6) were often built upon personal observations but clearly align with scientific evidence. Other studies in the region supporting community member perceptions show a decrease in biodiversity following afforestation of grasslands, negative impacts on soil quality, increased erosion, and soil acidification (Bremer and Farley, 2010; Jones and Grant, 1996).

Our results support findings of Diaz et al. (2015) who report people's negative attitudes related to the fire risks of tree plantations (63% of survey respondents) and tree plantation negative impacts on surface and ground water (38% and 48% of respondents, respectively). We found similar concerns, although respondents in our study expressed greater concern about tree plantation effects on water regulation than their potential as a fire hazard. Diaz et al. (2015) also found that over 70% of survey respondents had positive attitudes about the useful products obtained from tree plantations, the generation of jobs from tree plantations, and their potential in helping mitigate climate change. Respondents in our study described the useful products obtained by tree plantations, but perceptions about job creation and job availability were divided between the communities with more positive perceptions in the forestry industry-dominated community of Ubajay and largely negative perceptions in the community of La Criolla. We did not find any mention of tree plantations as helping mitigate climate change in our analysis, although respondents often mentioned their contribution to air purification (i.e. air quality regulation). The fact that our results support those of Diaz et al. (2015) underscores the general attitudes of people toward tree plantations in Pampean region of Argentina.

Results from this study highlight people's concern about poor and unsafe working conditions, job insecurity, lack of access to health care, and inadequate wages related to tree plantations as well as other forestry-related jobs in general. Bardomás (2007) describe the vulnerability of migrant tree plantation workers, suggesting that both the temporary nature of work combined with poor living conditions creates chronic insecurity of employment and income for these displaced individuals. Others note increasing rates of poverty with the expansion of tree plantations (Andersson et al., 2015). These issues were emphasized in both of our case study communities, suggesting that the scale of industry and size of tree plantations may not be a factor in determining whether these issues are ameliorated by a greater forestry presence.

4.3 Mutual benefits and drawbacks: eucalyptus developments as a catch 22

We found that respondents in both communities described eucalyptus developments both positively and negatively, suggesting potential tradeoffs of the eucalyptus industry. Mutual benefits and drawbacks commonly described include positive economic benefits at the expense of productive and fertile soils. Tradeoffs between socioeconomic benefits and ecological costs are common as a result of land use change (Carreño et al., 2012). The differing perceptions between the communities reflect the respective size of industry and the scale of value added development in each community. However, as demand for wood products continues, the forestry industry could grow in both communities. In this case, people's perceptions of tree plantations, especially in La Criolla, could change through time, shaped by the size of industry and scale of tree plantations. Therefore, individuals may eventually come to view tree plantations as commonplace, placing a high value on tree plantations just as they once had for citrus plantations simply to maintain the status quo of that land use which was previously perceived as the norm (Cockerill and Groothuis, 2014; Groothuis, 2010).

5. Conclusion

Our place-based assessment illustrates that ecosystem services are perceived as integrated concepts sometimes combined with indicators of well-being, and not always defined in the same way as in common frameworks such as the Millennium Ecosystem Assessment. People perceive provisioning and cultural services as most important while not identifying half of the MEA supporting services.

Ecosystem service frameworks such as the MEA provide a platform for understanding the benefits people obtain from the environment and how those contribute to well-being. However, place-based assessments are needed to truly understand how local people conceptualize ecosystem services in order to appropriately consider these services in land management decisions. Further, the ES concept itself must be used with caution in assessing how people attribute importance to and value the environment because an individual's perceptions are bounded by their own biases, and the state and type of environment that surrounds them. Place-based assessments can provide a means for understanding how these particularities shape people's perceptions, and in-depth, exploratory research especially helps illuminate how people relate with, understand, and value their environment.

This work shows that people's perceptions of how eucalyptus developments affect ecosystem services and well-being are context dependent and correlate closely with the size of industry and scale of tree plantations in their communities. Value-added products such as wood pellets have the potential to help ameliorate some of the negative impacts noted by respondents by creating new markets that provide jobs and income for local communities. However, our results indicate that labor conditions and workers' rights within the Argentine forestry industry require serious reevaluation if tree plantations are to provide true benefits. Sustainability certification along the entire commodity chain could help support these important human dimensions within the forestry industry. As global demand for biofuels drives the expansion of tree plantations, the social element must be understood and incorporated if sustainability is the desired standard.

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Chapter 3: The role of land tenure and land use history in shaping tree plantation developments in Argentina

Abstract

Tree plantations and the related forestry industry are expanding across the Americas to support global demand for bioenergy and wood products, to promote conservation efforts by alleviating pressure placed on native forests, and as a climate mitigation strategy to increase carbon sequestration. In Argentina, landholders are increasingly investing in tree plantations under the country's Plantation Investment Law, afforesting grasslands and replacing traditional pasturelands and citrus plantations. However, few studies have explored how land use history and patterns of tenure in Argentina shape tree plantation developments, and how tree plantations affect existing land tenure. We used a qualitative comparative case study analysis to explore how eucalyptus plantation developments are shaped under different land use and tenure situations, and how these are affected by tree plantations. Results indicate links between land tenure and land use history in determining location, size, and characteristics of eucalyptus developments. In-depth interviews reveal that people's perceptions of eucalyptus developments effects on ecosystem services align clearly with local land tenure and land use history. While people in a community with a longer history and larger scale forestry industry had generally positive perceptions related to the economic benefits of tree plantations, people in the community with a smaller scale forestry industry and smaller landholdings associated with citrus production were less optimistic about eucalyptus plantations in general. Similarities in concerns about the loss of smallholders with the rise of absentee landowners were expressed in both communities. This work contributes to a growing body of literature that explores factors contributing to understanding the sustainability of woody biofuels across the Americas.

Highlights:

- Land tenure history influences patterns of tree plantation developments
- Land use type is historically shaped by size of landholding
- Perceptions generally correlate with scale of forestry industry and size of tree plantations

Keywords: bioenergy, land tenure, land use change, perceptions, tree plantations

1. Introduction

Rising global demand for bioenergy and wood products is expected to drive an increase in the area of land dedicated to tree plantations in the coming years (FAO, 2015a). More recently, countries seeking carbon-neutral alternatives to fossil fuels are promoting woody biomass as a source of renewable energy, furthering the demand for plantations (Bais et al., 2015). Sustainably produced biofuels using wood residues have the potential to help lower greenhouse gas emissions while simultaneously providing benefits to local people (Tilman et al., 2009; Williams, 1994). However, short rotation tree plantations provide only temporary carbon storage (Schroeder, 1992), and carbon sequestration by soil uptake is highly variable (Paul et al., 2002). Further, biofuel developments can contribute to insecure land tenure situations, increased poverty, restricted land accessibility through land price increases, and changes in land tenure through land grabbing and consolidation by corporate absentee landowners (Andersson et al., 2015; Borrás et al., 2012; Cotula et al., 2008; Pimentel et al., 1984). These issues, among others, are well documented in relation to soy production for biodiesel in Latin American countries such as Argentina (Leguizamón, 2014), but little research has explored these issues as they related to tree plantation developments in Argentina as plantations expand and residues begin to be used for bioenergy.

Exotic tree species have been used in Argentina as wind breaks and decorative vegetation since the late 1850s (INTA, 1995). In the 1940s, the first industrialized tree plantations in Argentina were established in the Misiones and Entre Ríos Provinces (INTA, 1995). A country-wide shortage of wood pulp needed for making newspapers among other products including pallets for the growing citrus industry were impetus for the initial expansion of tree plantations in the late 1950s (INTA, 2012). In the 1970s the entire Southern Cone (Argentina, Brazil, Chile, and Uruguay) had tree plantation projects underway, with those in Argentina developed under the aid of tax breaks and subsidies (Sánchez Acosta, 1999). By 1999 policymakers released Law N° 25080 (hereafter the Plantation Investment Law), extended with Law N° 26432 in 2008, to provide direct incentives for investment in plantation forestry (Table 1). The Argentine government passed the Plantation Investment Law with the goal of increasing domestic wood supply by providing benefits to new and existing industrial forest projects (MAGyP, 1999). Currently, woody residues from tree plantations and sawmills are underutilized, but renewable energy targets in the country and abroad have encouraged their utilization in wood pellet production and cogeneration as renewable biofuels (Uasuf and Becker, 2011).

Table 1

Law N° 25080: Plantation Investment Law

General descriptions	Tax benefit details
<ul style="list-style-type: none"> • Enacted 1999 and in force through 2018 (extended by Law N° 26432 in 2008) • Aim: incentivize new forestry projects and extend existing ones • Creates an inventory process for established tree plantations • Establishes agreements with international organizations focused on development and technology transfer to the forestry industry • Provides tax benefits and economic support for domestic and foreign investment in forestry projects • Incentivizes management activities, irrigation and tree production, seed acquisition, research, and gathering and manufacturing wood products 	<ul style="list-style-type: none"> • Accelerated amortization on income taxes • Reimbursement of value-added tax for the purchase and import of goods, leases or services related to forestry activities • Accelerated depreciation on capital goods affected by forestry activity • Government finance of up to 80% of the total cost of cultivation projects (300 hectares or less) • Finance of up to 20% of total cost for cultivation projects 301-500 hectares • Tax stability for 30-50 years on forestry investment projects (value-added tax excluded from fiscal stability) • Maximum amount of incentive depends on: 1) the province in which the project is developed; 2) the species of the trees used; 3) the density of the plantation; 4) the number of hectares developed • Forestry activities must be part of an integrated forestry development

The National Support for the Use of Renewable Energy Sources Law, or Law N° 26190, outlines broader renewable energy targets that support the growing Argentine forestry industry by promoting the use of forestry industry residues as bioenergy feedstocks. Such woody feedstocks are increasingly used to manufacture wood pellets used as a renewable energy source, and as a source of energy generation for sawmills. In the city of Concordia, Province of Entre Ríos, wood chips are used as a feedstock in power production for heating kilns that dry eucalypt timber products (Uasuf and Hilbert, 2012). Other forestry biomass products in Entre Ríos include timber and wood pulp. A limited amount of mechanical wood processing by-products is used as biomass by paper, pulp, and particleboard industries in Argentina. The small-scale use of wood as bioenergy feedstock may shift towards larger scale use due to the rapid annual growth rates of pine and eucalypt species and the rising global demand for bioenergy and related feedstocks (Uasuf y Hilbert, 2012).

In early 2015, the first large-scale wood pellet plant in Argentina was opened by the locally-owned company known as Latin American Renewable Energy S.A. (Lare S.A.) in the city of Concordia, Province of Entre Ríos

(Ministerio de Cultura y Comunicación, 2015). Forestry industrial residues are bought from sawmills within an 80-kilometer radius and annual production is expected to average 75,000 tons. Approximately 80% of the pellets produced will be exported to Spain while the remaining 20% will be used locally (Ministerio de Cultura y Comunicación, 2015; Prensa Concordia, 2013). Until the installment of the Lare S.A. pellet plant, forestry industrial residues from tree plantations and sawmills were largely underused and in many cases burned at the mill site in open air. Law N° 25080 complements goals under Law N° 26190 by encouraging the expansion of tree plantations using pine and eucalyptus species (principally *E. grandis* in Entre Ríos) that provide forestry byproducts viable for pellet production.

The expansion of tree plantations across Latin America has generated conflicts at the local, national, and international levels (Paruelo, 2012). Recent studies suggest destabilized land tenure situations, restricted land accessibility through land acquisitions (Gerber, 2011), land concentration and socioeconomic decline (Charnley, 2005), insecure jobs, dangerous working conditions (Bardomás, 2007), links to increasing poverty, and other negative socioeconomic consequences (Andersson et al., 2015). Charnley (2005) points out that the large upfront costs associated with tree plantations as well as slow economic returns make plantation investments better suited for large-scale operations, creating difficulties for small landowners to become involved in the industry. Other studies point out ecological consequences including negative impacts on soil fertility, water regulation, and biodiversity (Bremer and Farley, 2010; Jobbágy and Jackson, 2004). At the same time, others suggest that tree plantations could be beneficial, providing economic benefits, climate, flood, and erosion regulation, and removing pressure on native forests depending on where tree plantations are established (Jobbágy et al., 2012; Wright and Gaitan, 2000). A few studies have explored people's perceptions of these possible benefits and drawbacks to tree plantations in the region (Diaz et al., 2015; Paruelo, 2012; Vihervaara et al., 2012), but few have explored how these positive and negative impacts may be mediated by land tenure regimes.

Our work aims to elicit people's perceptions of tree plantations within the Argentine context. We explore these perceptions using a mixed-methods comparative case study analysis across two communities with different land tenure and land use histories within the same province. We use scale of forestry industry and size of tree plantations as independent variables for our analysis. We focus on how historical land tenure and land use histories shape the way in which the current industry and size of tree plantations developed through time. By comparing historical land tenure and land use history trends, we can uncover how differences in size of landholding may influence land use type and patterns of land producer participation in incentive programs under Law N° 25080. This

is important in guiding policy formulation so that participation in tree plantation incentives is not limited to more asset-rich investors (Haltia and Keipi, 1999), and traditional land uses are not forced out by incentive programs (Beattie, 1995). We also assess how perceptions of the impacts of tree plantations differ across these communities, exploring how these perceptions may be shaped by the scale of forestry industry and size of tree plantations. Our main research questions for this study were as follows: 1) How are eucalyptus developments shaped by land tenure and land use history?; and 2) Do these different tenure and land use histories influence community member perceptions about eucalyptus developments impacts on human well-being? How and why?

2. Methods

A literature review and a review of historical land use and land tenure provide background and context for analysis of how these historical characteristics shape eucalyptus developments. We use GIS analyses of average patch size to provide comparisons between current community land uses. In-depth, qualitative interviews were used to gather community member perceptions on tree plantations.

2.1 Study sites

Our study area is in northeast Argentina in the Entre Ríos Province within the bordering Departments of Colón and Concordia (Fig. 1). We purposively selected two communities with different land tenure histories and landholding sizes to analyze community member perceptions of tree plantations. Ubajay in the Department of Colón was founded in 1912 and has an agricultural and forest industry-based economy (Table 2). La Criolla in the neighboring Department of Concordia was founded in 1930 and has a more diversified economy traditionally based on citrus, but more recently comprises small tree plantations, blueberry plantations, and several other agricultural production systems. A comparative case study analysis allowed for comparing and contrasting perceptions of tree plantations in communities that vary in their land tenure history and dependence on and development of this land use type.

The number of farms in Entre Ríos Province and Colón and Concordia Departments has decreased since 1947 (Table 1, Appendix 5). Most recent data (2002) show that individual owners make up the majority of landowners according to National Agricultural Census records of landholdings by type of land title for Entre Ríos Province and Colón and Concordia Departments (Table 2, Appendix 5). Formed associations make up the next largest group of landowners within these political boundaries according to land title data.

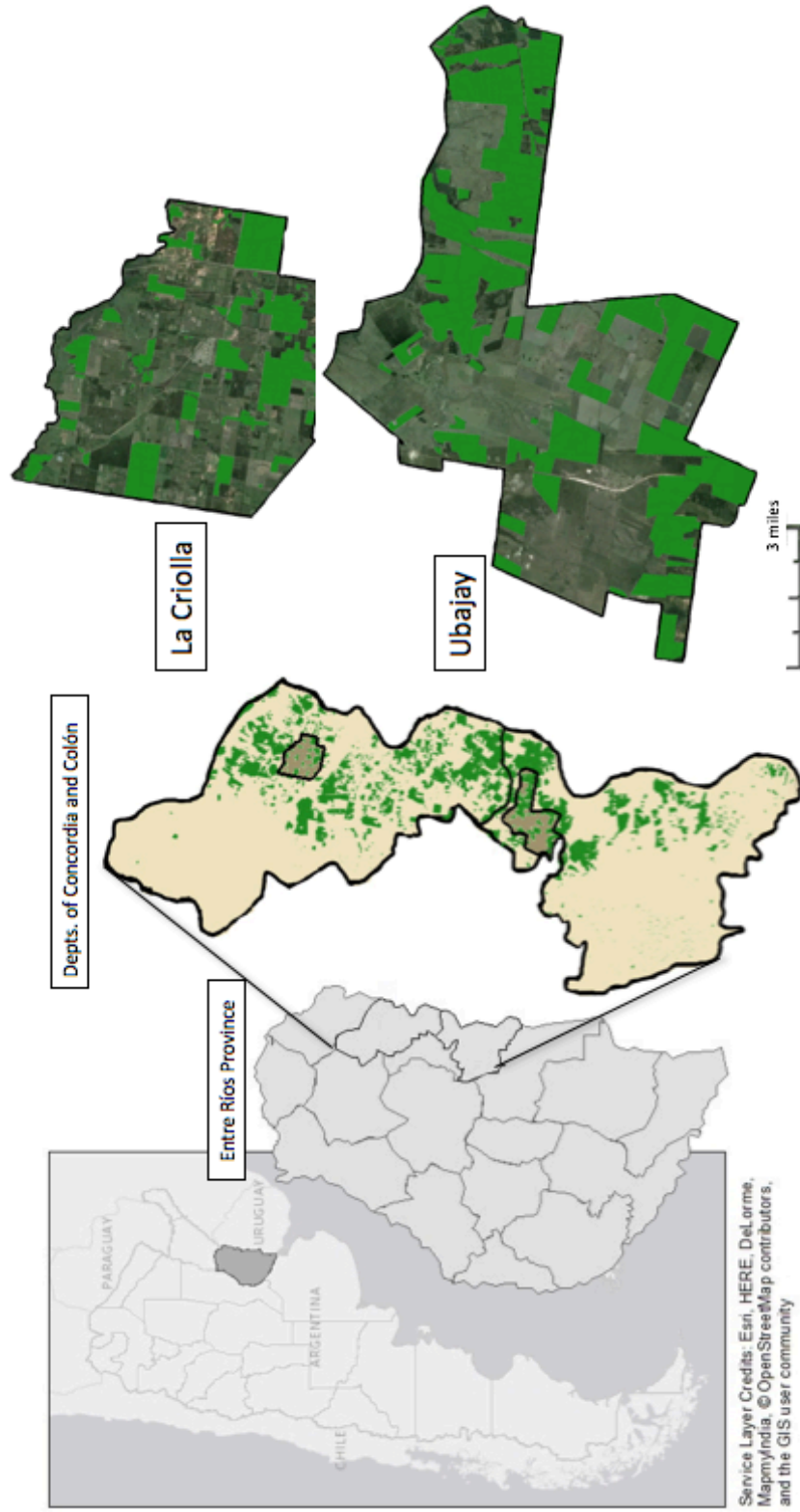


Figure 1. Study sites of La Criolla and Ubajay within the Departments of Concordia and Colón in the Entre Ríos Province of Argentina. Green areas show tree plantations. Three-mile scale refers the communities of Ubajay and La Criolla (Map created using data from the Forest Plantation Map made available online by SIIA [Sistema Integrado de Información Agropecuaria] under the Ministry of Agroindustry's Direction of Forestry Production).

Table 2
Comparative case study community descriptions

Variables	Ubajay	La Criolla
Department	Colón	Concordia
Year founded	1915	1930
Current land uses	Plantation forestry, other (aviculture, beekeeping, cattle grazing, rice, sorghum, soy)	Citrus, blueberry, plantation forestry, other (aviculture, beekeeping, cattle grazing, pecan)
Historical land uses	Agricultural production (e.g. wheat, rice, corn, flax, canary seed, barley, sorghum, sunflower), aviculture, cattle grazing	Citrus, other (viculture, olive production, cattle, rice)
General landholding sizes	Large	Small to medium
Average patch size (hectares)	34.6	15.7
2001 Population	2,334	1,852
2010 Population	3,507	2,382
Percent change in population (2001-2010)	+50.26%	+28.62%
Forestry industry	<ul style="list-style-type: none"> • 9 sawmills within municipal boundaries (9 others within 30km totaling 18) • 1 nursery (largest in Entre Ríos) • 70% population receiving direct income from forestry industry 	<ul style="list-style-type: none"> • 1 sawmill • 2 pressure treatment plants
Unemployment rate (department level) (2010)	3.67%	4.59%
Housing conditions (2001)		
Excellent	45%	36%
Good	26%	32%
Poor	13%	23%
Very Poor	17%	9%

Source for forestry industry data for Ubajay: (Gobierno de la Provincia de Entre Ríos Consejo Federal de Inversiones, 2009); Source for forestry industry data for La Criolla: Respondent interview data

Average patch size determined through remote sensing analysis of Landsat8 images. The word “patch” refers to delineations of different land uses (including citriculture, cropland, espinal, rangeland, and tree plantations)

Data for population, unemployment rate, and housing conditions obtained from the 2001 and 2010 National Population Censuses of Argentina.

Housing conditions provide one means for understanding the socioeconomic conditions of communities in Argentina. These figures are determined through National Population Census data referred to as CALMAT (Quality of Building Materials Used for Housing). We use 2001 data, as 2010 data at the municipal level is incomplete and thus incomparable.

2.2. Literature review and historical land use and land tenure analyses

In order to assess the influence of land use and land tenure history on the development of tree plantations we used data from a variety of sources. We conducted a literature review on historical land uses focused on the Province of Entre Ríos dating back as far as the late 1890s. This resulted in a collection of government documents, industry reports, and anecdotal references that provide historical context on land use information within the Entre Ríos Province. The Ministry of Agriculture, Livestock, and Fish (recently renamed the Ministry of Agroindustry) has extensive information on area planted as well as producers enrolled in the incentive and subsidy programs under Law N° 25080, providing current and historical data on tree plantation developments across the country. We compare land producer landholding data obtained from in-depth interviews with average patch size (both described below) to understand current municipal level land use trends.

2.3 Interview sample selection

We used a purposive criteria snowball sampling technique to identify a subgroup of the population in each community based on descriptive community roles identifying respondents as land producers or non-producers (Table 3). We define land producers as individuals who own land used for production purposes including eucalyptus tree plantations and/or production of citrus, blueberries, cattle, chickens, and pasture. We aimed for at least one third of our sample to be land producers. Snowball sampling allowed for selection of participants across a range of pre-determined community roles. By identifying multiple community roles a priori which capture the social and organizational structure of the community members potentially affected by tree plantations a diversity of perspectives is thereby ensured (Becker et al., 2003).

2.3.1 In-depth, qualitative interviews

In-depth, qualitative interviews were conducted in Spanish during May through July 2014. Interviews were conducted in-person and lasted between 30 minutes and 3 hours. We conducted interviews in teams as a precautionary safety measure and as a means for gathering data that are more robust. We hired and trained local professionals to provide linguistic and cultural support. The University of Oregon's Institutional Review Board reviewed and approved the interview protocol, and we sought verbal consent before commencement of each interview (Attachments 1 and 2). We required that all interviewers enroll in and pass the Collaborative Institutional Training Initiative (CITI) program prior to conducting interviews. This provided training for interviewers on human subjects protection and Responsible Conduction of Research issues.

The interview questionnaire included a series of 39 questions of which a subset was used for analysis in this study. Questions pertained to community, land use history, landholder land information, tree plantation developments, and perceived impacts on ecosystem services (Attachments 3 and 4). These questions included:

- *Land and production* (e.g., How have people traditionally gained access to land in your community? What types of landowners are there? Do you own land? How do you use the land? Have the owners of the land changed in the last 15 years? Has the amount of land that landowners own changed in the last 15 years?)
- *General community structure* (e.g., How would you describe your community? What do you like about your community?)
- *Ecosystem services* (e.g., What do you like about the environment? What benefits do you receive from the environment? Have you noticed these benefits change through time? If so, how and why?)
- *Forestry industry* (e.g., Has the development of the tree plantations in this region positively or negatively affected your community or the environment? If so, how?).

Questions about land and production were asked to draw understanding of local land tenure and land use histories. Community characteristics and structure were asked to triangulate understanding of ecosystem services, well-being, and the perceived effects on these. Forestry industry questions were used to elicit perceptions of tree plantation effects on well-being and ecosystem services (i.e., benefits received from the environment).

2.3.2 Qualitative data analysis

All interviews were recorded and subsequently transcribed for analysis in Spanish. We used QSR International's NVivo 10 qualitative data analysis software to analyze interview response data through systematic theming and categorization. Preliminary themes were based on field notes and data gathered by listening to interviews while transcribing. These initial themes were modified through the iterative process of coding and querying the data (Miles et al., 2014). This method allowed major themes to be separated out from more minor themes within a large data set.

2.4 Calculating land use patch size

We collaborated with colleagues at the National Institute of Agricultural Technology (INTA) and the University of Buenos Aires to create a land use map from remote sensing analysis of Landsat 8 images with 95% overall accuracy and a 30-meter resolution of the eastern portion of Entre Ríos to include both Ubajay

and La Criolla. The main land uses of focus were rangelands, crops, tree plantations, espinal, and fruiticulture (fruiticulture includes citrus as well as blueberries). Espinal is the natural areas dominated by shrubs and grasses. We used georeferenced photos, voice recordings, and local landowner data as a means for ground truthing and calibrating the remote sensing data through direct observation. We used Landsat 8 images (red and infrared reflectance) for eight dates from 2013-2014. The classification method used was Supervised Classification with majority voting from five rating methods (Maximum Likelihood, Support Vector Machines, Random Forest, LOGIT and Neural Networks) and five repetitions modifying subsets of training and validation. We then drew the approximate city boundaries of our study sites (La Criolla and Ubajay) in Google Earth using urban boundary maps obtained from the Entre Ríos Direction of Statistics and Censuses (access these maps [here](#)). We used a mask on the land use map for surrounding areas that were not included in the analysis. We then vectorized the land use map of La Criolla and Ubajay and calculated the area for each land use polygon.

3. Results

3.1 Different land use histories

Semi-nomadic, hunter-gatherer groups occupied the Pampas region for thousands of years prior to the settlement of Europeans in the region (Fonseca et al., 2013). European settlers took control of these lands for cattle ranching throughout the 18th and 19th centuries. These settlers began developing the agricultural sector in Entre Ríos with the 1876 Argentine Law of Immigration that allocated landholdings through land grants and sales (Adimistración de Parques Nacionales, 2006; Winsberg, 1964). At that time, Entre Ríos Province was split into two large estancias, or land parcels, that the government administered directly (Peyret, 1889). The government officially declared the estancias to be used for colonization purposes in 1872 (Peyret, 1889).

Colonization occurred by different means throughout the Entre Ríos Province and the country, often determined by settlement deals between colonizers and large landholders. In Ubajay and other Argentine colonies, philanthropist Baron Mauricio de Hirsch distributed landholdings and provided a house, well, equipment, horses, and cattle under 20 year payment plans at five per cent interest per annum to Russian Jewish immigrants through the Jewish Colonization Association beginning in 1891 (Adimistración de Parques Nacionales, 2006; Winsberg, 1964). Russian and Polish Jews immigrated to Argentina to escape religious persecution with over 175,000 Jews migrating to Argentina during the period of Jewish mass migration, from the late 1800s to the early 1900s (Winsberg, 1964). Landholdings distributed under the JCA were 109

hectares and were originally used for crop production (primarily wheat) (Winsberg, 1964).

While the intention of the JCA was to build a society of Jewish agriculturalists in Argentina, most Jews that immigrated through the JCA program were business owners and city dwellers in their nations of origin (Winsberg, 1964). Thus, many JCA Jewish immigrants began their lives in Argentina as agriculturalists, but ended up migrating to the cities in search of business careers and the familiar city life. This allowed those Jewish families that continued as farmers to buy up surrounding landholdings, thus expanding landholdings to sizes large enough for cattle grazing to become a profitable land use activity (Winsberg, 1964). Crop production (including mostly wheat, flax, rice, and corn) and cattle grazing dominated the landscape up until the 1970s when small and medium sized landholders began establishing tree plantations (Adimistración de Parques Nacionales, 2006). This trend in shifting land use to tree plantations continues today.

Colonizers in the Entre Ríos Department of Concordia were either granted landholdings or bought landholdings under the Law of Immigration (Peyret, 1889). Flora Urquiza, daughter of General Justo José de Urquiza, and her husband Gregorio Soler began distributing and donating lands through land grants to settlers in and around La Criolla (previously known as Villa Juan Bautista Alberdi) in the late 1800s (de Giacobino, 2014). Immigrants brought tools to work the land and were granted plots of land for agricultural production and building homes (Bermani et al., 2005). Soler had entrepreneurships in vineyards, citrus plantations, and olive oil production and stood out for importing European citrus plants (Bermani et al., 2005). Realizing the potential of the citrus industry, Soler subdivided his large landholdings into smaller plots which he easily sold at high prices (Bermani et al., 2005). With his vision of expanding the citrus industry, people attribute the origin of the citrus industry in Concordia and the creation of La Criolla to Soler and his wife Flora Urquiza (Bermani et al., 2005). Of course, despite these specific shifts in landholding size in and around both Ubajay and La Criolla, not all of the large estancias across Entre Ríos were converted into small or medium parcels organized into communities or colonias. Substantial areas remained as large landholdings throughout time.

In the late 1800s, viticulture dominated the landscape in the Department of Concordia and remained the primary agricultural activity through the mid-1930s (Bermani et al., 2005; INTA, 2012). The Great Depression led the government to create Regulatory Boards in 1935 that used government oversight to determine the production volume of agricultural commodities as a means for controlling market prices (Bermani et al., 2005). Under the new Regulatory

Boards, grape and wine production in Entre Ríos was limited in order to account for surplus production in the Mendoza and San Juan Provinces (Bermani et al., 2005). At the same time, citriculture was creating better economic margins in the Concordia Department, so producers slowly began replacing vineyards with citrus plantations (Bermani et al., 2005).

The citrus industry rose and fell through the years, with economic instability, disease, and periods of drought and other unfavorable climatic conditions causing serious declines in production and economic returns throughout the years (Bermani et al., 2005). By the time of the 2001 economic crisis in the Argentina, export volumes and revenue decreased, and barriers imposed by the European Union devastated the internal and external citrus markets (Bermani et al., 2005). Many citrus producers left the citrus industry altogether, while others opted for replacing citrus plantations with alternative production systems such as blueberry and tree plantations (Bermani et al., 2005). Bermani et al. (2005) suggests that producers viewed this transition as a great loss of a traditional way of life, and a potential threat to the region where the citrus industry historically provided many jobs. Currently landholdings average 25 hectares in La Criolla (personal communication, Director of Production, La Criolla).

3.2 In-depth interview landowner participants

We interviewed a total of 66 respondents, including 9 land producers in Ubajay and 15 in La Criolla, who combined represented a total of 18 different landholdings (Table 3). Land producers made up 38% of our total sample, or 32% and 43% of respondents in Ubajay and La Criolla, respectively.

Table 3
Interview respondent demographic data

Variables		Ubajay	La Criolla	Totals
Respondents		31	35	66
Gender	Male	52%	57%	55%
	Female	48%	43%	45%
Community Role				
Non-Landowner ^a		68%	57%	62%
Landowner		32%	43%	38%
Landowner Holdings	Average	895	46	376
	Range	12-3,000	10-100	10-3,000

^aIncludes 11 sub-categorizations: community leader, culture, education, elder, general, health, history, landworker, local business, newcomer, other worker

Small farms make up the majority of our respondents in La Criolla with 100% of respondents owning farms 100 hectares or less in size (Table 4). Landholding sizes varied more in Ubajay, with 43% of respondents owning farms of 500 or more hectares in size. Data from the National Agricultural Census of Argentina (2002) show that landholdings greater than 5,000 hectares in size make up 12.1% and 18.8% of the Colón (Ubajay) and Concordia (La Criolla) Departments, respectively.

Table 4
Percent landholdings from interview data by size of landholding

Farm size (ha)	Ubajay	La Criolla
0-10	0%	27%
11-25	29%	9%
26-100	14%	64%
101-500	14%	0%
501-1,000	14%	0%
1,001-5,000	29%	0%
>5,001	0%	0%
Total	100%	100%

Farm size percentages for interview respondents are based off the number of interviews rather than the number of respondents to not double count these figures for the same household (where in some cases we interviewed no more than two family members).

3.3 Community level land use

The Municipality of Ubajay is over three times the area of La Criolla and the mean average patch size is more than twice as large in Ubajay as in La Criolla (Table 5). Indeed, the average patch size of every type of production except for fruticulture is nearly twice as large in Ubajay as in La Criolla. Tree plantations make up the largest land use in Ubajay followed by rangelands, whereas rangelands cover more area followed by tree plantations in La Criolla. In Ubajay, fruticulture makes up less than one percent of land use while in La Criolla it covers 13%. Tree plantations make up 45.3% of land use in Ubajay whereas in La Criolla they make up almost 40%.

(Results continue on the next page)

Table 5

2014 land use data for Ubajay and La Criolla

Type of production	Total hectares		Percent of total		Average patch size (ha)	
	Ubajay	La Criolla	Ubajay	La Criolla	Ubajay	La Criolla
Fruiculture	38	584	0.3%	13.0%	2.5	11.0
Cropland	1,928	396	14.3%	8.8%	31.1	5.7
Espinal	809	95	6.0%	2.1%	14.5	3.2
Tree plantations	6,094	1,696	45.3%	37.8%	80.2	42.4
Rangelands	4,587	1,720	34.1%	38.3%	45.0	16.2
Totals (or mean average size):	13,456	4,491	100.0%	100.0%	(34.6)	(15.7)

3.4 Plantation Investment Law participation versus non-participation

Beneficiaries under Law N° 25080 (the Plantation Investment Law) are largely comprised of small and large producers (Table 6). Small and large producers are distinguished by:

- 1) The number of hectares dedicated to establishing tree plantations (small producer: <10 ha; large producer: >10 ha)
- 2) The number of hectares dedicated to forestry activities (small producer: <50 ha; large producer: >50 ha).

Small producers in Entre Ríos make up over half of all producers receiving benefits under Law N° 25080 (Table 6). Small producers only own 16.8% of the land developed under this law in Entre Ríos while large producers own over 83% of the area developed in the province. The total hectares developed under the Plantation Investment Law (Table 6) make up roughly 80% of the 1.1 million hectares of tree plantations developed nationwide (MAGyP, 2014a). The remaining 20% of tree plantations were established without payments under the Plantation Investment Law.

In Ubajay, we found that absentee producers owned many of the large tree plantations. While these producers do benefit from the incentive program, it is largely through the tax benefit component of the law rather than the direct payment component as outlined in Table 6 (INTA forest engineer, person communication).

The total hectares devoted to tree plantations increased nearly 40% from 1990 to 2015 in Argentina with the greatest increase occurring over the fifteen-year period 1990-2005 (Fig. 2). At the same time, roundwood harvests have increased at a rate greater than the rate of hectares developed (MAGyP, 2015a), indicating intensification on tree plantations. The number of hectares developed under the Plantation Investment Law in Entre Ríos Province increased almost

nine fold from 2003 to 2015 (Fig. 3). The number of hectares developed peaked in 2005 and then again in 2012, after which the number of hectares developed declined sharply. The number of Argentine Pesos granted under the law follows a similar trend, except after 2013 when pesos granted increases while hectares developed decreases.

Table 6

Producers benefiting under Law N° 25080 as of September 2015 in Argentina and the Entre Ríos Province

	Data type	Small groups	Small advances	Community advances	Small producers	Large producers	Totals
Entre Ríos	Amount approved (\$)	15,804	-	-	16,005,527	88,540,808	104,562,139
	Total producers	12	-	-	1,254	1,060	2,326
	Area forested (ha)	44	-	-	3,314	37,219	40,577
	Area pruned (ha)	-	-	-	10,760	39,374	50,134
	Area thinned (ha)	-	-	-	1,487	7,823	9,310
	Area managed (ha)	-	-	-	4,677	15,602	20,279
	Area enriched* (ha)	-	-	-	-	60	60
	Total hectares	44	-	-	20,238	100,078	120,360
Argentina	Approved amount (\$)	44,751,391	3,446,868	88,369	114,241,813	730,748,859	893,277,300
	Total producers	20,735	381	1	11,198	6,937	39,252
	Area forested (ha)	19,659	134	-	43,585	334,872	398,250
	Area pruned (ha)	507	186	-	43,344	276,496	320,533
	Area thinned (ha)	179	85	-	11,390	95,184	106,838
	Area managed (ha)	-	-	-	6059	22,132	28,191
	Area enriched* (ha)	262	59	-	1,225	9,347	10,893
	Total hectares	20,607	464	-	105,603	738,031	864,705

Small groups: Presentations of small foresters in aggregate form

Small advance: Payment of 50% of small foresters plan (up to 5 ha of afforestation and up to 15 ha of tasks)

Community advance: Payment of 50% of the plan for Indigenous Communities (up to 50 ha of afforestation and up to 150 ha of tasks)

Small producers: Up to 10 ha of afforestation and up to 50 ha of tasks

Large producers: More than 10 ha of afforestation and over 50 ha of tasks (up to 500 ha total [700 ha in Patagonia])

Figures rounded to the nearest tenth.

*Area enriched refers to enrichment of native forests to increase their economic value through thinning and other management techniques.

(MAGyP, 2015b)

(Results continue on Page 62 following Figures 2 and 3)

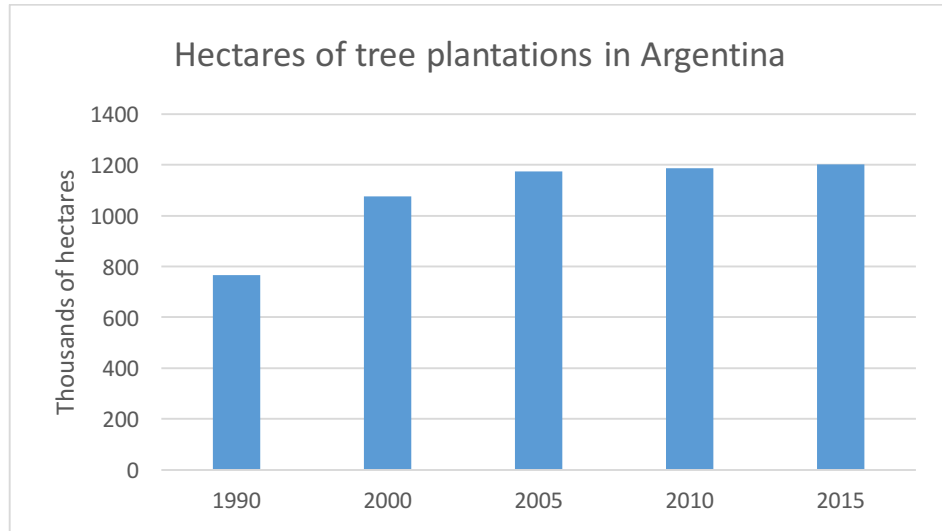


Figure 2. Total hectares of tree plantations in Argentina. These include those developed within and outside of programs under the Plantation Investment Law (FAO, 2015b).

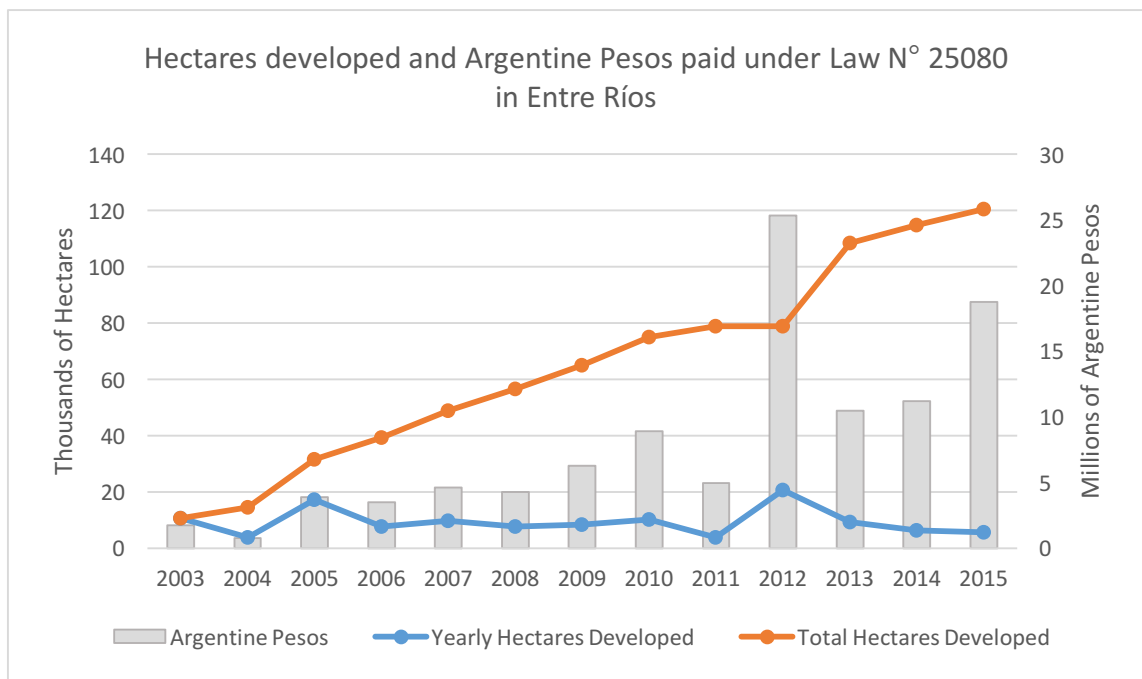


Figure 3. Hectares developed under Law N° 25080 in the Entre Ríos Province and Argentine Pesos allocated from 2003-2015 (MAGyP, 2015b).

3.5 Community perceptions of tree plantations under different land use histories and tenures

In general, community members in Ubajay described tree plantations and the extensive forestry industry as providing economic opportunities that allowed their community to progress. Regarding land tenure, community members expressed concerns related to the rising cost of land, land concentration by absentee owners and foreign investors, and the disappearance of small landowners. These concerns were discussed as general trends as well as specific trends related to tree plantation expansion in the region. Of the landowners interviewed, one major concern was that large landowners are getting larger as they buy up small landholdings, leaving fewer small landowners.

“Like I said before, today big companies buy up large extensions of land and so if a small producer wants to buy land, the price is very high and it’s more profitable [for the landowner] to sell the land to someone else who will pay more for large extensions...” [Respondent in Ubajay]

“I think that the lands here are held by fewer hands, and it’s foreign capital that come and buy up the land...I think that in the future we Argentines are not going to be landowners, instead land will all be owned by foreigners...and because land is sold to people outside of Argentina, the price of land increases and so the people in the community do not have money necessary to buy a piece of land” [Respondent in Ubajay]

“...here big companies buy tree plantations...hectares of tree plantations as if they were going to buy a bag of candy...and so for big companies it is much easier than for small producers who remain small and it is very, very difficult for them [small producers] to advance...” [Respondent in Ubajay]

Community members in La Criolla were generally less positive about the ability of tree plantations to provide economic benefits, describing the expansion of tree plantations as displacing previously available jobs and not providing any new jobs. Major community concerns included the loss of a prosperous citrus industry due to high inflation, debt, and climate change, and the rise in anonymous absentee landowners buying up small landholdings to plant eucalyptus and blueberry plantations. The following quotes exemplifies these concerns:

“...we had to sell...because we asked for a bank credit but we could not pay it. It was a credit from the national bank...but it was in U.S. Dollars and when we had asked for the credit the [exchange rate] was one to one and later they charged us in dollars...impossible to pay it back...the moment arrived when they began auctioning off lands and we thought they

were going to auction off ours...we had to abandon the farm because we had no money to maintain it...that is, until corporations from the United States, who we did not know, came and wanted to buy our land. They offered good money and so with that we paid our debt...we sold them forty hectares and we kept ten” [Respondent in La Criolla]

“What’s the problem? Let’s talk about the reality for us here – the problem is that tree plantations are winning out over citrus plantations...investors from other places such as Buenos Aires or foreigners buy up lands from producers that are on the brink of economic failure and do not see a future [in citrus production] ...” [Respondent in La Criolla]

Small landowners and community members discussed the difficulty in accessing subsidies and incentives under the Plantation Investment Law, mostly because the program requires costs paid upfront by the landowner, thus small owners that do not have upfront capital felt they could not benefit from the program:

“You have to have a lot of money, and they ask you for so many things that a small producer cannot do...I tried two or three times. I went to the meetings to see if things had changed at all...for example, I requested a subsidy...because I wanted to plant eucalyptus maybe not for me, but for my grandchildren, but they did not grant me one...” [Respondent in La Criolla]

“...the [subsidies] are only accessible to large producers...there isn’t a single small producer who can actually access the tree plantation subsidies...” [Non-landowner respondent in Ubajay]

Community members described effects of tree plantations on ecosystem services in both a positive and negative light in Ubajay and La Criolla (Table 7). Regarding the socioeconomic effects of tree plantations, both communities highlighted concerns about the inadequate wages, unsafe working conditions, and employment instability associated with black market labor that relies heavily on immigrant laborers. Respondents in La Criolla expressed concerns related to losing traditional cultural values tied to citrus plantations as eucalyptus plantations replace this traditional land use. Ecological effects of tree plantations were viewed similarly in the two communities, however it should be noted that more respondents in La Criolla than in Ubajay noted negative impacts on soil fertility and nutrient cycling associated with tree plantations.

(Discussion begins on Page 65 following Tables 7 and 8)

Table 7

Perceived effects of timber industry on well-being

Positive	Negative
Basic materials for a good life - <i>Job opportunities</i> - <i>Opportunities for local rural development</i>	Basic materials for a good life - Few job opportunities provided - Displaces existing jobs
Security - <i>Job stability</i>	Security - Unsafe working conditions - Poor workplace living conditions - Black labor market exploiting immigrant laborers - Increased fire risk

Text *in italics* refer to perceptions from Ubajay.Text **in bold** refers to perceptions from La Criolla.

Plain text refers to perceptions identified in both Ubajay and La Criolla.

Table 8

Perceptions of tree plantation effects on ecosystem services

ES Category	Positive	Negative
Provisioning	- Wood products - Economic benefits	- Few economic benefits - Native plants and animals (tree plantations destroy habitat)
Regulating	- Air quality - Pollination (provide valuable pollination for beekeepers)	- Air quality (emissions from sawmills and burning residue wood piles) - Natural hazards (increase fire risk) - Water regulation (loss of surface water and groundwater)
Cultural	- Aesthetic values (forest-like quality)	- Aesthetic values (degrades the open landscape) - Cultural heritage values (loss of traditional land use [citrus])
Supporting	- Photosynthesis	- Soil fertility and quality (decreases)

Text *in italics* refer to perceptions from Ubajay.Text **in bold** refers to perceptions from La Criolla.

Plain text refers to perceptions identified in both Ubajay and La Criolla.

4. Discussion

Evidence from in-depth interviews and patch size data suggest larger tree plantation developments found in Ubajay and smaller plantations found in La Criolla. Historically larger landholdings and a land use history based on grazing cattle and grain and seed crops influenced the development of these larger tree plantations in Ubajay.

4.1 Linking land use and tenure history with tree plantation establishments

Tree plantation establishments are expanding across Latin America (FAO, 2015a). Many tree plantation developments occur through government subsidy and grant programs such as the Plantation Investment Law (Law N° 25080) in Argentina. Tree plantations cover approximately 154,000 hectares in the Entre Ríos Province of Argentina, and over 1.1 million hectares nationwide (MAGyP, 2014a). Approximately 80% of hectares developed nationwide are associated with plans under the Plantation Investment Law (MAGyP, 2015c). Pertinent to understanding these tree plantation developments is examining how land tenure and land use history influence who establishes tree plantations and how tenure and land use histories shape plantation developments and community member perceptions about the socioecological effects of tree plantations.

Our results indicate that land tenure at the municipal level may play a part in determining who develops tree plantations. Current landholdings are much larger in Ubajay than in La Criolla. We find the average patch size of tree plantations to be almost twice as large in Ubajay as in La Criolla, which parallels our community level findings on landholdings (i.e., findings from in-depth interviews). We also found that tree plantations make up a slightly higher percentage of land use in Ubajay, perhaps implying greater investment in tree plantations in the community. Important to note is that evidence from our community interviews suggests that many of the large tree plantations in Ubajay are owned by absentee landowners. This could be an indication of the type of tenure situations that are more common for establishing tree plantations in the region. Andersson et al. (2015) suggest that the forestry industry may target areas with fewer smallholders, where buying up vast tracts of land is simplified since populations are sparse and land deals less complex. The fact that absentee landowners seem to develop larger tree plantations also makes sense, as tree plantations require little management during the course of tree maturity. In addition, global trends towards more large-scale operations motivated by economies of scale might lead investors to seek larger landholdings for tree plantation developments (Charnley, 2005; Gerber, 2011).

Land tenure is an important factor in determining one's ability to participate in forestry incentive programs. We find that those who participate in the Plantation Investment Law programs in Entre Ríos are split rather evenly between small and large producers (small and large as defined in Table 6) (MAGyP, 2015c). However, 20% of existing tree plantations were established outside of programs under the Plantation Investment Law. Low prices for land, land quality, and guaranteed return on investment (Rubio, 2006) may be enough for wealthy investors from Buenos Aires and other absentee landowners outside the country to develop tree plantations without government aide. Such factors might also encourage investors to develop large-scale tree plantations that maximize profits. However, tree plantation developments over 500 hectares (700 ha in Patagonia) do not qualify for benefits under the Plantation Investment Law and so developments of this large scale must occur without government benefits.

Although the ratio is relatively even for small and large producers developing tree plantations in Entre Ríos, results from in-depth, qualitative interviews suggest community level concerns about the increase in land concentration in the region. These concerns are warranted as a recent study notes that Pampean agriculture production increasingly demands larger capital investments, and larger landholdings are better suited for large-scale mechanization (Gras, 2009). As Gras (2009) notes, this follows global trends from government aims to incorporate the agricultural sector into the global market. The Argentine government accomplished this globalization of the agricultural sector through deregulation, trade liberalization, the Argentine Peso-US dollar convertibility plan, and the elimination of protective measures and some production incentives. Increasing concentration of land might create an imbalance in the ratio of small and large landholder participants under the Plantation Investment Law as the demand for and expansion of tree plantations continues through time.

Land use history could be playing a role in shaping who participates in the forestry incentive programs in Argentina. Industrial tree plantations first appeared in the 1940s, but the real expansion in tree plantations began with the implementation of the Plantation Investment Law in 1999. Our results indicate that small and medium-sized producers began establishing tree plantations earlier on in Ubajay, beginning in the 1970s (Adimistración de Parques Nacionales, 2006), while tree plantations appeared in La Criolla after the 2001 economic crisis (Bermani et al., 2005). The state of the economy and its effect on different agricultural sectors throughout time explains these differences. Historical land uses in Ubajay included row crops and cattle grazing while in La Criolla vineyards originally dominated the landscape, followed by an almost century-long landscape dominated by citrus plantations. Landholders in Ubajay sought out alternatives to cattle ranching and agricultural crops in the 1970s and began

establishing tree plantations. Conversely, citrus plantations in La Criolla and the entire Concordia Department, while faced with waves of economic and climatic setbacks throughout time, remained the dominant land use until the 2001 economic crisis that either forced producers completely out of the citrus sector or required that they diversify in other production systems such as tree plantations (Bermani et al., 2005).

4.2 Perceptions of tree plantations between large and small-scale plantation forestry developments

Respondents in Ubajay and La Criolla expressed both positive and negative attitudes towards tree plantations. However, the fact that most respondents focused their discussion on employment and economics provides grounds for understanding the general attitude towards tree plantations in each community. In Ubajay, respondents emphasized the importance of the forestry industry for their community. Indeed, about 70% of the community receives direct benefits from the industry through jobs and wages while the remaining 30% receive indirect benefits through businesses servicing forestry workers and forestry industry service providers (Gobierno de la Provincia de Entre Ríos Consejo Federal de Inversiones, 2009). Overall, respondents described the forestry industry as driving rural economic development in the community and stimulating an increased quality of life.

In La Criolla, respondents did not describe tree plantations as part of a larger industry as respondents did in Ubajay, most likely due to the lack of forestry industry in La Criolla (especially compared to Ubajay, known regionally as the “wood capital”). Respondents emphasized that a change in land use from citrus plantations to tree plantations, without incorporating value added forestry industry activities, created a deficit in the jobs available within the community. Torres et al. (2015) find that tree plantations provide fewer employment opportunities than other agricultural sectors. As Carámbula and Piñeiro (2006) point out, distinct patterns and histories of forestry development influence the quality and quantity of employment opportunities provided by the forestry sector. The longer history of forestry in Ubajay allowed for more stable growth of local forestry industry, leading to job opportunities on tree plantations as well as at local sawmills. In La Criolla, the seemingly rapid expansion of tree plantations in the community gave way to a relative absence of processing plants meaning that raw material from tree plantations are exported to other regions (including Ubajay). This leaves mostly jobs on tree plantations as the major source of employment from the forestry sector in La Criolla. Employment on tree plantations is often limited (i.e., few jobs available) and temporary (following a long-term management plan) (Bardomás, 2007; Carámbula and Piñeiro, 2006),

explaining concerns raised in La Criolla regarding loss of employment with land use change to tree plantations.

Countering the disparity in perceptions between Ubajay and La Criolla regarding employment opportunities provided by tree plantations and the forestry industry was the consensus between the two regarding the precariousness of tree plantation labor and job insecurity linked to the black market labor that relies on immigrants. Bardomás (2007) observed these issues and others related to the forestry industry in Entre Ríos, noting that the precariousness and unfamiliarity of work on tree plantations leaves the local workforce reluctant to take these jobs, requiring forestry companies to recruit laborers from other provinces and countries. The fact that these issues Bardomás (2007) identified these labor and social justice issues almost a decade ago is significant because tree plantations have expanded considerably since then which could mean that these issues are affecting an even greater number of people across the country.

Also worth noting are the community perceptions on the effects of tree plantation on cultural heritage values and land ownership. Shifts in land use from agricultural production systems to tree plantations could alter traditional community lifestyles where the communities themselves manage and work the land during the harvest seasons and are thereby supported year-round by the local land use. Discussion of cultural heritage values was largely restricted to La Criolla, where community members described tree plantations as replacing traditional land uses (i.e., citrus) and in so disregarding the cultural heritage tied to these production systems.

Finally, in both communities people expressed concern about the loss of small landowners and increase in land concentration by foreign absentee landowners and large companies, who often establish eucalyptus, soy, or blueberry plantations. National Agricultural Census data from Argentina (INDEC, 2002) show a general trend in diminishing numbers of smallholders and increase in large landholders in the region, although these figures do not suggest that such changes in land tenure relate directly to tree plantation expansion. The Plantation Investment Law provides tax benefit and economic support for foreign investors, but Law N° 26737 limits the land available to be sold to foreign investors (USDA, 2013). Further research could provide insight into the links between tree plantations in Argentina with land concentration and foreign absentee landowners and large companies.

5. Conclusion

Our results indicate that land use and tenure history appear to play a role in shaping the current development of tree plantations in the Entre Ríos Province and community perceptions of these plantations. Ultimately, those investing in tree plantations have a history of land use associated with agriculture and raising cattle, while those with a land use history associated with citriculture only recently began investing in tree plantations. We also see a relationship between land tenure history and investment in tree plantations. We found a slightly higher percentage of tree plantations for overall land use in Ubajay where landholdings are larger than in La Criolla where landholdings are much smaller. These links between land use and tenure history and tree plantation developments are important considerations for decisionmakers seeking to support more sustainable tree plantation expansion regarding the human dimensions of emerging wood-based bioenergy projects.

Global demand for wood products is on the rise, and Latin America is responding with incentive programs to develop tree plantations. As countries search for more sustainable alternatives to fossil fuels, trees plantations may be targeted as a bioenergy feedstock source. In Argentina, Law N° 25080 gives landholders an opportunity to invest and diversify their land use with tree plantations. Although results from our study indicate that smallholders make up the majority of beneficiaries (albeit making up a small percentage of total hectares in production under the Plantation Investment Law), we find that smallholders struggle to enter the program and perceive it as difficult to access. At the same time, people worry about the disappearance of smallholders as large businesses and absentee landholders buy up land in the region, often to establish tree plantations.

These results support a reevaluation of the forestry incentive program. Future amendments to the Plantation Investment Law, which will require extension after 2018, should stimulate smallholder access to the benefits of the law in order to address the countrywide trend in diminishing numbers of smallholders. Another amendment should help stimulate local value added forestry industry, which would allow for local processing of raw materials from tree plantations, thereby providing local employment opportunities. A final amendment should incentivize land use diversification through agro-pasture-plantation systems, which would create more sustainable agricultural communities and help support highly valued traditional land uses. Such amendments together would discourage land concentration by absentee landowners seeking large-scale monoculture investments, a growing concern for these tight-knit Argentine communities.

Further research could provide more information on who receives benefits under the Plantation Investment Law programs and the role that absentee land ownership plays in tree plantation developments. As demand for wood products increases globally, our response must rest upon the three pillars of sustainability by providing society with environmentally, economically, and socially just options for the future.

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Chapter 4: Conclusion

A growing global population combined with an increasing need for energy resources means that nations around the world are seeking out new energy resources. Renewable resources are especially of interest across the globe because they offer an alternative to fossil fuels, which, in theory, helps mitigate climate change and secures an energy resource for generations to come. One such source of renewable energy comes from tree plantation residues and other forestry residues in the form of wood pellets and as cogeneration at sawmills. While wood pellets qualify as a renewable source of energy, concerns about the sustainability of their production along the commodity chain raises the question about the sustainability of tree plantations as well as biofuels in general.

One way to better understand the social, economic, and environmental effects of any production system is through place-based assessments that use in-depth qualitative interviews to gauge community perceptions. I used the Millennium Ecosystem Assessment as framework for analyzing how people perceive effects of tree plantations on their local communities and the environment in the Entre Ríos Province of Argentina. Key to this assessment was that I used a comparative case study that allowed me to examine how the size of tree plantations and scale of the forestry industry have an influence on local people's perceptions. Also important to this study was understanding how tree plantations and the forestry industry developed to be of different local sizes and scales in the first place.

Tree plantations and the forestry industry in the study area developed at different scales and over different periods of time. In Ubajay, where large tree plantations dominate the landscape and the forestry industry acts as the primary motor of the community I found that landholdings had historically been large and historical land uses were primarily grain and seed production and cattle grazing. In La Criolla, citrus plantations are historically the primary land use and landholdings developed to be much smaller than in Ubajay. Results from patch size analysis and interview landholder data show more, bigger tree plantations in Ubajay. These results suggest that the landholding size and land use history have an influence on patterns of tree plantation developments in the region. Large landholdings may be more attractive to outside investors than small landholdings because access to land is less challenging logistically, and management is simplified at the large scale.

Perceptions on tree plantations aligned clearly with the size and scale of tree plantations and the forestry industry in our two study sites. Results suggest that large plantations and a large-scale forestry industry are generally tied to positive perceptions from community members. Benefits cited from these large

developments in Ubajay include economic benefits and increased quality of life. Community members in La Criolla, with smaller plantations and a virtually non-existent forestry industry, conveyed largely negative perceptions about tree plantations, which they associated with few economic opportunities and displacing traditional, culturally relevant land uses, i.e. citrus.

My results show some shared perceptions between two communities with different scales of forestry industry and size of tree plantations. Both communities expressed concern about groundwater consumption by tree plantations, citing loss of surface water at local streams as well as depressed water tables. Another shared described concern related to poor working conditions, instability, and lack of worker's rights within the industry and especially on tree plantations where immigrants face exploitation as workers within a black market labor system.

My research suggests that while tree plantations have the potential to provide local economic benefits, the current distribution of benefits is not even across the Entre Ríos Province. In addition, tree plantations are having local environmental impacts that could affect other local production systems. Considering these issues, I present the following recommendations for building a more sustainable approach to tree plantation and forestry industry development in Argentina:

- Better enforcement of existing labor laws, thus addressing serious issues related to labor conditions and workers' rights within the industry
- Expand incentive policies for the forestry industry to enhance value added production systems, thus creating more socioeconomic benefits for communities that have tree plantations but current lack value added opportunities
- Enhance incentive programs to support diversified production systems, thus strengthening local economies and building trust with small producers who feel their cultural values are in jeopardy as tree plantations expand into their communities (e.g., incentivize integrated agro-pasture-forestry systems over monoculture tree plantations)
- Reevaluate suggested methods for establishing tree plantations that encourage production intensification and instead use extensification (e.g., planting fewer trees per hectare) thus alleviating pressure on highly valued water resources

Such measures might help communities move towards more socioecologically sustainable development of tree plantations, thus making the prospect for utilizing wood pellets and other wood products for bioenergy renewable in every sense of the word.

List of Appendices

Appendix 1: Informed Consent, Spanish Version

Hola mi nombre es [su nombre] y estoy trabajando como parte de un equipo de investigación para entender como los cambios en el uso de la tierra están afectando este área, su comunidad, su economía, y su medio ambiente con un enfoque sobre las forestaciones en la zona. Este es parte de un proyecto que abarca todas las Américas desde Canadá hasta Argentina. Estamos colaborando con INTA y CONICET en esta investigación.

Esta entrevista dura aproximadamente una hora. Tenemos una serie de preguntas sobre sus experiencias y punto de vista sobre el uso de la tierra y específicamente las forestaciones. Esta entrevista es completamente voluntaria entonces Usted puede terminar si no quiere seguir más con las preguntas en cualquier momento de la entrevista. No asociaremos su nombre con la información que nos da en ninguna forma de los datos o informes que resultan de este estudio. La información de esta entrevista no sería accesible a nadie afuera de nuestro equipo de investigación.

No hay un riesgo previsto de participar en este estudio y tampoco beneficios directos para Ud., sin embargo sus respuestas servirán para aumentar en entendimiento de estos sistemas de producción en Argentina y las Américas.

¿Tiene preguntas para nosotros?

¿Está de acuerdo de participar en esta entrevista? Sí ___ No _____

Para no perder el sentimiento de sus palabras, me gustaría grabar la entrevista para capturar todo y utilizar la grabación en el análisis de los datos. No será utilizada afuera de nuestro estudio. ¿Está bien? Sí ___ No___

¿Tiene más preguntas para mí?

Si quiere una copia de esta carta, avíseme y puedo entregar la copia ahora o mandar por e-mail o fax. Si tiene preguntas sobre la investigación puede contactar a Dr. Kathleen Halvorsen at 01-906-487-2824 o kehalvor@mtu.edu. También puede hacer contacto con Dr. Julian Licata-INTA Concordia at 0345-429-0000 int 164. Si tiene preguntas sobre sus derechos o para hacer una queja, favor contactarse con Research Compliance Services en la Universidad de Oregon, +01 541-346-2510 o ResearchCompliance@uoregon.edu. Esta oficina no es participante en el estudio sólo para proteger sus derechos.

¡Gracias por su interés y participación en el estudio!

Appendix 2: Informed Consent, English Version

Hello, my name is [your name] and I am working as part of a research team to better understand how land use change is affecting this area, your community, its economy, and the environment with a focus on tree plantations in this region. This is part of a project expanding the Americas from Canada to Argentina. We are collaborating with INTA and CONICET in this research project.

This interview will last approximately an hour. We have a series of questions about your experiences and your point of view related to land use change and tree plantations in specific. This interview is completely voluntary and so if you decide you would like to stop the interview and you no longer would like to continue with the questions we can stop at any time. We will not associate your name with the information that you provide us in any form whatsoever with any of the reports or information that result from this study. The information in this interview will not be accessible to anyone outside of our research team.

There is no risk in participating in this study or any direct benefits for you; instead, your responses will serve to amplify the understanding of these production systems in Argentina and the Americas.

Do you have any questions for us?

Do you agree to participate in this interview? Yes No

So as not to lose the meaning of your words, I would like to record this interview to capture everything and use the recording in data analysis. The recording will not be used outside of our study. Would that be ok? Yes No

Do you have any other questions for me?

If you would like a copy of this letter, please let me know and I can give you a copy or send one by email or fax later. If you have any questions about the investigation, please contact Dr. Kathleen Halvorsen at 01-906-487-2824 or by email kehalvor@mtu.edu. You can also contact De. Julian Licata- INTA Concordia. If you have any questions about your rights or you would like to report a complaint, please contact Research Compliance Services at the University of Oregon. This office is not participating in this study; instead, it exists to protect your rights.

Thank you for your interest and participation in this study!

Appendix 3: Community Interview Questions, Spanish Version

INTRODUCCION

Para empezar vamos a hablar un poco de su trabajo y su comunidad.

1. ¿Por cuánto tiempo ha vivido/ trabajado aquí? ¿En qué trabaja para cubrir sus gastos?
2. ¿Cómo han cambiado las oportunidades de trabajo para usted en el tiempo en esta comunidad?
3. ¿Cómo describiría su comunidad? ¿Qué hace a su comunidad especial o única?
4. ¿Cómo describiría usted la calidad de vida y los modos de vivir en su comunidad?
5. ¿Cómo ha cambiado la calidad de vida y los modos de vivir durante el tiempo? ¿Qué es lo que ha impulsado estos cambios?
6. ¿Cuáles son los problemas más importantes que enfrenta la comunidad hoy?
7. a. ¿Cuáles son los retos/desafíos que piensa puede haber para el futuro de su comunidad?
b. ¿Cuáles son las oportunidades que piensa puede haber para el futuro de su comunidad?

Ahora vamos a hablar sobre el tema de tierras y producción en su comunidad.

8. a. ¿Tradicionalmente, cómo ha obtenido la propiedad de la tierra la gente en esta comunidad y en esta zona?
b. ¿Qué tipos de propietarios hay en esta comunidad?
9. ¿Usted tiene propiedad de la tierra, la arrienda o tiene conexión familiar?
¿Cuánto hectáreas?
 - i. ¿Dónde está ubicada esta tierra en relación a su comunidad?
 - ii. ¿Con qué frecuencia usted va allí? (¿cuántos veces por semana/mes/año?).
10. ¿Usted hace uso de la tierra?
¿De qué manera?
 - a. ¿En su tierra, cómo ha cambiado el uso de la tierra en el tiempo (tamaño de cultivos, tipo de cultivo, tipo de actividad de la tierra, los rendimientos (producción agrícola o citricultura o forestal)? ¿Cómo ha cambiado el uso de la tierra de generación en generación?
 - b. ¿Es su producción principalmente para consumo, uso comercial, ambos u otro? ¿Cómo contribuyen los ingresos de éstas actividades a la economía familiar?
 - c. ¿Ha realizado mejoras en su tierra? ¿Cuáles son las mejoras que usted ha hecho (pozos, sistemas de riego, alambrados, fertilización, etc.)?

- I. ¿Cuándo usted hizo estas mejoras?
 - II. ¿Cómo se financiaron? ¿y, Cómo se tomaron estas decisiones?
 - III. ¿Usted utiliza fertilizantes o agroquímicos?
 - i. ¿Ha cambiado la cantidad en el uso de estos (fertilizantes agroquímicos) en el tiempo?
 - ii. Si Usted no utiliza estos productos ¿Por qué usted tomó esta decisión y cuáles fueron las razones?
11. a. ¿Ha cambiado los propietarios/dueños de la tierra en los últimos 15 años en su comunidad y en los alrededores de su comunidad?
- ¿Cómo?
- i. ¿Afectaron estos cambios a los pequeños propietarios?
 - ii. ¿Afectaron estos cambios a los grandes propietarios?
- b. ¿La mayoría de las personas tienen título de propiedad de la tierra?
12. ¿La cantidad de tierra de los propietarios ha cambiado en los últimos 20 años?
- ¿Cómo cambió y por qué?
13. ¿Usted piensa que es importante para las futuras generaciones la posibilidad de ser dueños de la tierra y/o poder arrendarlas? ¿Por qué sí o por qué no?
14. ¿Cómo están involucradas las generaciones más jóvenes con el uso de la tierra hoy en día?
- a. ¿Cómo piensa usted que sus niños y las generaciones futuras van a usar la tierra?

Ahora vamos a hablar sobre el medio ambiente y la tierra y los efectos sobre su comunidad y familia.

- 15. a. ¿Qué te gusta del medio ambiente de tu localidad?
 - b. ¿Por qué es importante para su comunidad el medio ambiente?
 - 16. ¿Cuáles son los beneficios, si hay alguno, que usted o su familia reciben de su medio ambiente?
 - 17. ¿De estos beneficios, cuales son más importante para usted?
 - 18. ¿Cómo afectan estos beneficios, que usted ha mencionado que reciben del medio ambiente y las tierras a su comunidad? ¿Son positivos o negativos?
 - a. ¿Cómo afectan estos beneficios a los que son de afuera de su comunidad?
 - 19. ¿Hasta ahora, estos beneficios se han visto modificados en el tiempo?
- ¿Cómo y por qué?
- a. ¿La valoración y/o importancia que usted da a estos beneficios ha mejorado o empeorado en estos últimos 15 años?
 - b. i. ¿Cómo usted piensa que estos beneficios cambiarán en el futuro?

- c. ¿Las forestaciones con eucalipto o pino generaron cambios que posibilitan y/o facilitan que la gente pueda usar las tierras?
 - d. Estos cambios que usted describió por las forestaciones con eucalipto o pino, ¿Cómo han afectado a la identidad de su comunidad?
24. a. ¿Cómo han cambiado sus sentimientos respecto al eucalipto o pino desde que se cultivó por primera vez en su comunidad o en la región?
- b. ¿Por qué?
25. [Si da referencia a preocupaciones de la gente, dice:] ¿Los miembros de la comunidad han trabajado para abordar las preocupaciones, si hay, sobre cómo se desarrolla el eucalipto en su comunidad?
- a. ¿Cómo, y con qué éxito o fracaso? ¿Sí/No, por qué?
26. En general, ¿Cómo se siente acerca de la producción de eucalipto en la comunidad y alrededor de esta?
- a. ¿Usted está a favor o en contra? ¿Por qué?

Ahora queremos hablar sobre la utilización de la biomasa

27. ¿Usted sabía del desarrollo de la bioenergía local antes de esta entrevista?
- ¿Qué ha escuchado?
- [Si no explica la forma de utilización o conversión de bioenergía en la zona como *“Pues en Concordia están construyendo una fábrica de pellets para exportar a Europa donde la gente puede utilizarlas en sistemas de calefacción. También hay aserraderos que están utilizando aserrín y otros residuos para producir calor para secar madera y también para producir energía”*]
28. ¿Por qué usted piensa que la utilización de rastrojo de cosechas y/o residuos de madera con eucalipto está siendo promovido o desarrollado como biomasa?
29. ¿Usted piensa que el gobierno debería alentar facilidades para convertir o utilizar el eucalipto para su uso de combustible, pellets, calor o electricidad? ¿Por qué sí o por qué no?
30. ¿Usted piensa que el uso de rastrojo de cosechas y/o residuos de madera con eucalipto para hacer combustible, pellets, calor, electricidad, briquetas y/o carbono es algo bueno? ¿Por qué sí o por qué no?
- a. ¿Y si usara todo el árbol para estos usos?

Ahora queremos hablar de la sustentabilidad en su comunidad y en los sistemas de producción

31. ¿Qué significa para usted la idea de sustentabilidad en su comunidad?
32. ¿Usted escuchó de la certificación sostenible de las forestaciones de eucalipto?
- ¿Ha cambiado la manera en que maneja el eucalipto?
33. i. ¿Cómo podrían ser más sustentables las actividades del uso de la tierra que dominan en esta comunidad?

[Espera la respuesta y si hay dificultad con ‘sustentable’, dice: “*O sea, ¿Qué mejoraría de los aspectos ambientales, sociales, políticas, y económicos, para que las generaciones futuras tengan asegurado una igual o mejor calidad de vida y medio ambiente?*”]

Ahora queremos [*hablar sobre los grupos/individuos involucrados en las forestaciones y*] ver si Usted tiene preguntas que debemos averiguar.

34. ¿Quiénes son las empresas o propietarios privados que desarrollan el eucalipto en esta región? ¿Qué tipos de interacciones o experiencias ha tenido usted con ellos y en qué medida?
35. Con relación a la producción de eucalipto, ¿Usted tiene preguntas relacionadas con los impactos sociales, económicos, o ambientales que piensa que nuestro equipo debería investigar? ¿Cuáles preguntas le gustaría tener contestadas?

Algunas preguntas sobre Ud.

36. ¿Cuántos años tiene?
37. ¿Tiene un auto/camioneta/moto? Sí____ No____
[Si tiene auto, pregunta:] ¿Qué marca y modelo?

Para terminar la entrevista solo dos preguntas más

38. ¿Hay personas, organizaciones, empresas, o entidades importantes que no hayamos mencionado hasta ahora? ¿Hay otros temas importantes que no discutimos?
39. ¿Con quién en la comunidad me recomendaría hablar sobre estos temas

Gracias por su tiempo y disponibilidad de compartir sus conocimientos y pensamientos.

FIN

Appendix 4: Community Interview Questions, English Version

To begin we are going to talk a little bit about your job and your community.

1. How long have you lived / worked here? What do you do for a living?
2. How have job opportunities for you changed over the years in this community?
3. How would you characterize your community? What makes it unique?
4. How would you describe the quality of life and livelihoods here?
5. How has this quality of life and livelihoods changed over time? What has driven these changes?
6. What are the most significant challenges your community faces? [economic, environmental, political, social, health]
7. What challenges and opportunities do you anticipate for the future of your community?

Now we are going to talk about land and production in your community.

8. How have people traditionally gained access to land in this community? What kinds of landowners do you have here?
(private/individual/corporate/absentee/renting)?
9. Do you own land, rent land, or have a family connection to land? If so, how much? What type (own land/have title to/familial connection or rent land)?
 - a. Where is this land located in relation to your community? How do you get there and how long must you travel? How often do you go there?
 - b. Has the amount of land that you have access to changed over the last 15 years? If so, how and why?
10. Do you use land? [If yes,] in what ways (agricultural production, firewood, livestock, hunting, etc.)?
 - a. How has your use of land changed over time [size of cultivations, types of crops/land activities/yields (agricultural production)]? How has the use of land changed across generations?
 - b. Is production primarily for consumption, commercial purposes, both, or other? How do these activities contribute to your household?
 - c. What, if any, improvements have been made to the land (wells, irrigation, fencing, etc.)? When were these improvements made, how were they funded, and how were these decisions made?
 - i. (If applicable) Are fertilizers, pesticides, herbicides, etc., used? If so, how are they obtained?
 - ii. If these products are not used, how was this decision made and what were the criteria (expense, availability, risk, environmental concerns, etc.) and has the amount used changed over time?

11. Have landowners in this community and the surrounding communities changed in the last 15 years? How?
 - a. Did these changes affect small producers?
 - b. Did these changes affect large producers?
 - c. Do most people have clear title to their lands? [If not, why not?]
12. Have the number of producers changed in the last 15 years? How any why?
13. Do you think land ownership and access is important to future generations? Why or why not?
14. How are younger generations involved with land use today?
 - a. How do you think your children / future generations within your community will use land?

Now we are going to talk about the environment and land and the effects on your community and family.

15. What do you like about the environment here? In what ways is this environment important to your community?
16. What benefits, if any, do you or your family receive from ecosystem/nature/landscape/the earth/soils /grasslands [control and treatment landscape descriptions such as forest, plantation, grasslands, woodlot]?
17. Of these benefits which are most important to you?
18. How do these benefits affect your community? Or outside of your community? [For example, structure of the community, dynamics, demographics, values, etc.]
19. Have these benefits changed over time? If so how and why?
 - a. Are they more or less valued today than they were over the past 15 years?
 - b. How do you think these benefits might change in the future? Will the changes be good or bad and why?
 - c. Has the availability of resources (animals and plants) changed over time? [If yes] How and why?
20. What needs to be done to ensure the protection of these benefits for future generations?
 - a. [If respondent indicates government intervention]: What types of government policies or programs do you think would be most effective?

Now we will talk about eucalyptus production and the use of eucalyptus products.

21. Do you use eucalyptus firewood in your home? If so what for and how much on an annual basis?
22. Do you engage in production of eucalyptus? If so, when did you begin?
 - a. What was the previous land use?
 - b. What scale is your annual production?

- c. Do you plan to cultivate more in the future? Why?
 - d. Who purchases your production?
 - e. What motivated you to engage in eucalyptus production? (Prompt policy, income opportunity, diversification of income, other)
 - i. If mention policy--Would you be producing without policy/subsidies?
 - ii. What laws, rules, or policies most influence your production practices?
23. Has this eucalyptus development positively or negatively affected your community and the environment? [If yes] How? (Prompt on biodiversity, water, cultural, food, soil health, equality, land ownership employment)
- a. How has eucalyptus development changed the benefits others in your community and from outside the region receive from the environment? Why? What do you attribute these changes to?
 - b. Have the eucalyptus plantations changed the possibility or availability to buy or rent land in your community?
 - c. Have the eucalyptus plantations changed the possibility for people to use land?
 - d. How have the changes you described affected the identity of your community?
24. How have your feelings toward eucalyptus plantations changed since it was first cultivated in your community or region? Why?
25. Have community members, groups or organizations worked to change how eucalyptus plantations have developed to address community concerns? If so, how and with what success or impact? If not, why not?

Now we would like to talk about the use of biomass.

26. Had you heard about local bioenergy development before this interview? [If yes:] What have you heard? [If not then explain the idea behind bioenergy transformation in the site or from the feedstock]
27. Why do you think wood pellets using forestry industry wood residues [biomass production/utilization/conversion] is being promoted or developed?
28. Do you think the government should encourage utilization of eucalyptus residues for wood pellets? Why or why not?
- a. What if the whole tree was used for wood pellets rather than just the woody residues?
29. Do you think that using eucalyptus residues to create wood pellets is a good thing? Why or why not?
30. Overall, how do you feel about the [bioenergy feedstock production or utilization/conversion] in and around your community? (support or oppose?) Why?

Now we would like to talk about sustainability in your community and in the systems of production.

31. How would you define sustainability in your community?
32. Have you heard of eucalyptus sustainability certification? Has it changed the way the [bioenergy feedstock] is developed/managed?
33. How could land use activities here be more sustainable? What would be your vision of a more sustainable [land use type]? What would improve the environmental, social, political, economic dimensions of quality of life?

Now we would like to talk about the groups or individuals involved in tree plantations and see if you have any inquiries that we should investigate.

34. Who are the key private firm entities / landowners in eucalyptus in the area? What kinds of interactions / experiences have you had with them, to what effect?
35. Related to eucalyptus production do you have any questions related to social, economic or environmental impacts that you think our research team should investigate? What questions would you like answered?

And now some questions about you.

36. How old are you?
37. Do you have a car, truck, or motorcycle? If so, what model and year?

Finally, we would like to end the interview with two more questions.

38. Are there any other important people, organizations, businesses, or entities we haven't talked about? Are there any other important topics we didn't discuss?
39. Who else in the community should I talk to about these topics? Specifically about eucalyptus production.

Thank you for your time and willingness to share your thoughts and knowledge.

Appendix 5: National Agricultural Census of Argentina Comparisons

National Agricultural Censuses (CNA) from 1947, 1988, and 2002 provide historical land tenure information and a means for analyzing trends through time and between departments (note: 2008 was the last agricultural census conducted in Argentina, but data sets were largely incomplete and thus remain unused in this study).

Land tenure situations have changed through time in Entre Ríos Province, and in particular have witnessed a decrease in the total number of farms. The total number of farms decreased 39% over the fourteen-year period 1947-2002 in Entre Ríos with a 52% decrease in Colón (Ubajay) and a 59% decrease in Concordia (La Criolla), respectively (Table 3). The number of farms of 501-5,000 hectares increased in Colón, following the overall trend in the Entre Ríos during the period 1947-2002. Farms of the same large size decreased during this period in Concordia. All farms less than 500 hectares in size decreased in these departments and the province overall. Comparisons of more recent data from 1988-2002 again show decreases in the overall number of farms in the Colón and Concordia Departments and the Entre Ríos Province. However, large size farms of 500 or more hectares increased provincially, but showed an average decrease in numbers in both Colón and Concordia. This is counter to the longer-term trends of farm numbers in Colón (1947-2002).

Table 1

Percent change in number of farms through time by farm size

Farm size (ha)	Percent change 1988-2002			Percent change 1947-2002		
	Colón (Ubajay)	Concordia (La Criolla)	Entre Ríos	Colón (Ubajay)	Concordia (La Criolla)	Entre Ríos
0-10	-33%	-48%	-39%	-54%	-85%	-65%
11 to 25	-38%	-10%	-29%	-60%	-51%	-45%
26-100	-29%	-36%	-21%	-59%	-56%	-44%
101-500	-30%	-30%	-18%	-27%	-52%	-30%
501-1,000	0%	+17%	+6%	+172%	-21%	+51%
1,001-5,000	-20%	-21%	+10%	+39%	-47%	+42%
>5,001	0%	0%	+27%	0%	-67%	-14%
Overall	-30%	-29%	-20%	-52%	-59%	-39%

Data compiled from the 1947, 1988, and 2002 National Agricultural Censuses of Argentina. Comparisons are between the Departments of Colón and Concordia, and the Province of Entre Ríos.

Another means by which to understand changes in land tenure is by comparing changes in the number of farms and hectares recorded under different land title categories (Table 2). At the provincial level, the number of farms titled as formed associations decreased almost 50% from 1988-2002 while public limited companies were the only category of land title to see an increase in

numbers (18%). The number of farms under the cooperative and other category increased 400% in the Colón Department, although the number of hectares under this category decreased by almost half during this period (1988-2002). Formed associations in the Colón Department decreased 56% during this time. In the Concordia Department, the number of farms and hectares categorized under the cooperatives or other land titles decreased more than any other land title category for this department (69% and 81%, respectively).

In 2002 (most current data), individual owners make up the majority of land titles in the Entre Ríos Province and in both Departments of Colón and Concordia. Formed associations follow, in both numbers of farms and numbers of hectares held by land title category.

Table 2: Percent change 1988-2002 and total number of farms and hectares in 2002 by land title category

Department or Province		Total	Persona física (individual owner)	Sociedad de hecho (formed association)	SRL, SA, SCA (public limited company)	Cooperative or other
A) Percent change 1988-2002 in number of farms and hectares by land title category						
Entre Ríos	farms	-20%	-15%	-49%	+18%	-24%
	hectares	+2%	+8%	-24%	+24%	-44%
Colón (Ubajay)	farms	-30%	-25%	-56%	-29%	+400%
	hectares	-18%	-16%	-23%	-20%	-49%
Concordia (La Criolla)	farms	-32%	-28%	-49%	-8%	-69%
	hectares	-20%	-14%	-54%	23%	-81%
B) Total number of farms and hectares by land title category in 2002 (by percentage of total)						
Entre Ríos	farms	100%	83%	12%	4%	0%*
	hectares	100%	54%	18%	27%	1%
Colón (Ubajay)	farms	100%	85%	12%	2%	1%
	hectares	100%	61%	21%	17%	1%
Concordia (La Criolla)	farms	100%	74%	17%	8%	1%
	hectares	100%	50%	18%	32%	0%*

Persona física (individual owner): the producer is the person that operates the farm as a successor.

Sociedad de hecho (formed association): the association of two or more people in order to exploit land, livestock or forests, without actually being legally registered as such. Members jointly assume the economic risk and make the principal decisions about the management of the farm; these formed associations included undivided societies.

SRL, SA, SCA: SRL: formed by several partners which limits their capital liability; SA (sociedad anónima): a partnership formed between several partners which limits their liability to corporate contributions and whose capital is represented by shares; SCA (company limited by shares: composed of two categories of partnerships (1. Companies who respond with social capital plus their own capital; 2. Limited partners who only respond to social capital)

Cooperative or other: Includes cooperatives, private non-profit organizations, public entities, and landholdings with unknown land titles.

*All values calculated to be less than 0.5 percent displayed as zero.

Data compiled from the 1988 and 2002 National Agricultural Censuses of Argentina.