

POLICY BRIDGE

Pathways to agroecological management through mediated markets in Santa Catarina, Brazil

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Agroecology, as a social movement and scientific discipline, applies ecological principles to the design and management of agricultural systems to improve environmental outcomes and livelihoods for farmers and rural communities. However, little research to date has assessed the policy mechanisms that could facilitate increased adoption of agroecological management practices. We investigated if and how public food procurement programs that provide financial incentives for organic and agroecological production can mitigate key constraints to agroecological transition. We explored the experience of participants in Brazil's National School Feeding Program (PNAE) in Santa Catarina, which offers both a structured market for small-scale family farmers and a price premium for certified agroecological production systems. We found that the PNAE provides an economic incentive for small-scale farmers to begin an agroecological transition by creating a price-differentiated market that is otherwise absent in the regional context. However, without external network linkages – such as participation in farmers' associations, cooperatives, and non-governmental agricultural extension programs that support agroecological practices – the influence of PNAE is limited in stimulating a broader scaling up of agroecological production.

Keywords: agroecology; constrained choice; policy transitions; Brazil; public procurement

1. Introduction

The well documented consequences of industrial agriculture include greenhouse gas emissions, biodiversity loss, soil erosion and contamination of surface and ground waters (Kremen et. al., 2012; Matson et. al., 1997; Tilman et. al., 2002), as well as a range of other social outcomes including the loss of rural employment (Araghi 1995) and health equity concerns related to exposure to agricultural chemicals (Weiler et al., 2014). In response, agroecological production systems aim to apply ecological concepts and principles to the design and management of agroecosystems to conserve natural resources (Gliessman, 2015) and improve the socioeconomic conditions of farmers and farm workers (Timmermann and Félix, 2015). Although the maintenance of traditional and indigenous practices is central to some definitions of agroecology (e.g., Altieri and Toledo, 2011), here we use a broader framing focused on the intentional transition from industrial to agroecological practices that reduce or replace synthetic inputs with ecological or biotic processes to improve

environmental and socioeconomic outcomes (Meek, 2015; Tomich et al., 2011). While several international organizations now actively promote agroecological practices (e.g., De Schutter, 2010; FAO, 2015; IAASTD, 2009), and the science of agroecology continues to advance (Kremen et al., 2012; Martin and Isaac, 2015; Isbell et al., 2017), less is known about the social and policy-related factors that can most effectively encourage farmer transitions towards agroecology.

While family farming systems across the globe are highly heterogeneous, they manage over half of the world's agricultural land (Graeub et al., 2016). Some scholars suggest that family farmers have tended to exhibit higher levels of adoption of agroecological practices (De Schutter, 2010; Perfecto and Vandermeer, 2010; Rosset and Martinez-Torres, 2012). Reviews suggest that diversified family farms can be highly competitive and efficient (Chappell and LaValle, 2009), have a greater capacity to manage biodiversity (Wittman et al., 2016) and contribute significantly to domestic food security and food diversity (Graeub et al., 2016). Despite these benefits, policies tend to support large-scale, industrial farming operations (Capelosso et al., 2016). It is therefore critical to identify and evaluate policy and decision-pathways for transitions to agroecological management systems on family farms (FAO 2014; Schmitt Filho et al., 2013).

The theory of constrained choice, originating in the field of public health (Bird and Rieker, 2008) and with applications to agriculture (Hendrickson and James,

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2005; Stuart, 2008), articulates how decision-making results from a defined relationship between individual agency and structural constraints, such as cultural, social-institutional and economic forces that mediate the range of options available to individuals. For example, economic constraints to the adoption of agroecological practices include increased costs or labour requirements (Darnhofer et al., 2005), the risk of decreased yields (Rodriguez et al., 2009), and lack of access to credit (Defrancesco et al., 2008; Falconer, 2000). Social or cultural norms and knowledge regimes can encourage both behaviour and attitudes that either support or constrain the adoption of agroecological practices (Burton and Paragahawewa, 2011; Fielding et al., 2005; Sutherland and Darnhofer, 2012; Montenegro de Wit and Iles, 2016).

Public food procurement programs are mediated market mechanisms that aim to use the power of public purchasing to achieve redistributive and development-related goals (De Schutter 2014; Wittman 2015). Public procurement includes the awarding of public food provision contracts that are structured to create incentives for food producers to implement agroecological management (Audet, 2003; De Schutter, 2014). The potential benefits of such programs are increasingly documented (De Schutter, 2010; Soares et al., 2013; Wittman and Blesh, 2017) and promoted by international institutions, such as the FAO and World Food Programme (WFP), as well as by social movements (e.g., La Via Campesina).

These programs represent a form of a government-mediated or “structured” market, involving mechanisms such as price floors; conditions on suppliers (e.g., gender or geographical based preference, organic or fair trade certifications); quota setting (e.g., market access ceilings); and demand structuring (e.g., food crops vs commodity crops or animal feed). As an ‘infrastructure of provision’ (Seyfang, 2011), public food procurement programs can serve as incentive structures to support agricultural development and other social and environmental goals. Furthermore, they are hypothesized to improve market access for marginalized farmers, reduce food insecurity through prioritizing food crop production, reduce poverty through fair prices and establish critical producer-consumer linkages, which may promote social and ecological sustainability (De Schutter, 2014).

Despite increased interest in public procurement programs, understanding the social mechanisms by which such programs affect adoption of agroecology is a critical knowledge gap. We broaden the discussion of constraints on farmer decision-making in agri-environmental management by examining the case of Brazil’s National School Feeding Program (*Programa Nacional de Alimentação Escolar – PNAE*) in the highlands of Santa Catarina, a small state in southern Brazil (see **Figure 2**) characterized by diverse agricultural landscapes dominated by family farming systems. Family farmers in southern Brazil tend to have highly favorable conditions for agriculture compared to other regions, including greater access to agricultural credit and infrastructure (Medina et al., 2015). We explored the extent to which farmer decision-making about agroecological

production practices is structurally constrained, and ask if and how participation in the PNAE can help mitigate constraints to adoption at the farm level. Specifically, the PNAE includes two components predicted to provide opportunities for agroecological transition: i) a local procurement mechanism and, ii) an economic incentive for producers who are certified organic and/or agroecological, including a 30 percent price premium and priority access to public food procurement contracts. We also examined the role of participation in agricultural networks (e.g., associations, cooperatives) and extension in agroecological transition.

1.1. Constrained choice and agroecology

Constrained choice theory looks at “how structural constraints narrow the opportunities and choices available to individuals”, altering but not eliminating their capacity for agency (Rieker et al., 2010, 62). Structural constraints refer to relations of power that are distributed differentially among individuals and classes, and which effectively create barriers through patterns of social organization that can endure over time (Abel and Frohlich, 2012). Hendrickson and James (2005) outline how the structural conditions of contemporary global agricultural systems, such as industrialization, market concentration and specialization, constrain decisions of farmers in the U.S. agricultural sector, potentially forcing farmers into decisions that conflict with their values. These authors focused primarily on the economic constraints, such as access to capital and credit-related debt.

These factors intersect with farmer agency and farm-level conditions, including (but not limited to) farm operation and management systems, to influence the adoption – or not – of agroecological practices (Blesh and Wolf, 2014). In **Figure 1** we represent the effects of structural constraints on adoption of agroecological practices. These constraints interact with farmer agency to determine whether and to what extent farmers “choose” to implement agroecological management practices, which both affect and are affected by farm-scale ecological conditions and processes. Adaptive or maladaptive feedback loops occur between farmer agency, structural constraints, and policy.

1.2. Constraints to agroecological transitions

The literature on structural constraints identifies several categories of constraints related to knowledge, economic, social, and cultural factors. Biophysical constraints are less commonly considered by social scientists, but are of particular importance for choices related to agroecological management. Constraints are related to: i) the characteristics of the farm (e.g., size, soil type, environmental conditions), ii) characteristics of the farm manager (e.g., educational level, social capital, availability of labour), iii) characteristics of management practices themselves (e.g., requirement for capital or other input investments, increased labour), and iv) external constraints (e.g., availability of credit, social networks, social norms, and legitimacy).

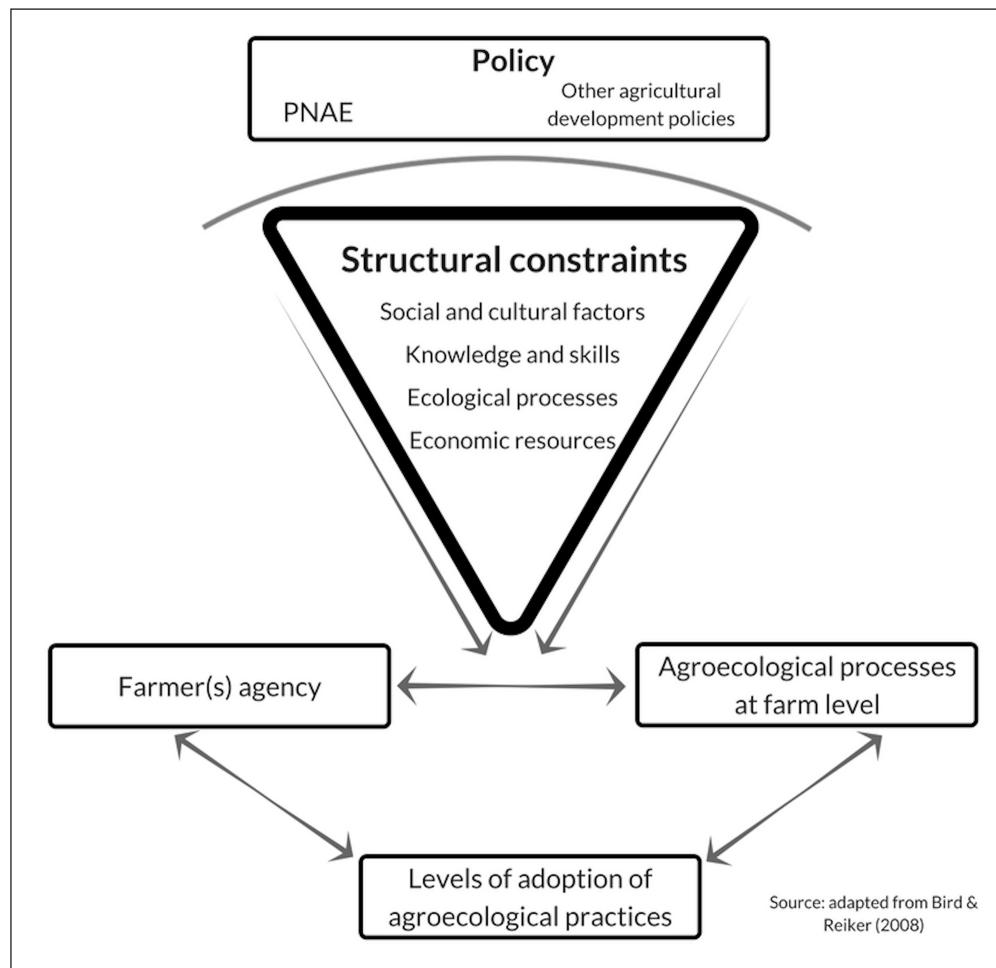


Figure 1: Constrained choice in agricultural management. The sphere of action within which farmers can make decisions about agricultural management is set both by the broad policy context and interacting structural constraints. These forces intersect with farmer agency and agroecological processes to affect the levels of adoption of agroecological practices. DOI: <https://doi.org/10.1525/elementa.248.f1>

1.2.1. Economic constraints

The economic variables influencing the adoption of agroecological practices include production costs, yields, market opportunities and the extent of financial compensation in the form of price premiums or payments. Changes to these factors can present either opportunities or constraints to adoption. Some studies have found that production costs are lower with agroecological practices because they require fewer inputs (e.g., no-till systems or using on-farm fertilizers in place of synthetic fertilizers) (Altieri et al., 2012; Knowler and Bradshaw, 2007). Lower production costs could reduce economic constraints to adoption. This is often used as a reason for promoting agroecological practices among low-income producers (Amekawa et al., 2010). However, some scholars caution against the assumption that low-income producers are using low-input agroecological practices by choice, as it is possible that economic constraints (e.g., price of synthetic fertilizer or machinery) are limiting their ability to use other methods (Valkila, 2009).

In contrast, other studies have found production costs for agroecological practices to require higher upfront investments (e.g., building a riparian buffer or purchasing cover crop seeds or other organic inputs), labour demands,

and certification costs (Defrancesco et al., 2008; IAASTD, 2009; Pimentel et al., 2005). If agroecological production costs are higher, adoption may be limited if farmers do not have sufficient access to labour, credit, an off-farm income stream, or sufficient revenue from their marketed crop to cover the costs (Darnhofer et al., 2005; Falconer, 2000).

In addition to production costs, many studies report farmers' concerns over potential for reduced yields as a barrier to transitions (Darnhofer et al., 2005; Rodriguez et al., 2009). However, yield effects are variable and depend on the point in transition, environmental conditions, land use history, and the cropping system itself (Ponisio et al., 2015; Seufert et al., 2012).

Price premiums or incentive payments are mechanisms used in a number of alternative agricultural models (e.g., organic agriculture, Payments for Ecosystem Services) to offset either increased costs or decreased yield associated with the adoption of environmentally beneficial practices. Some have found that financial compensation is a significant factor in adoption (Darnhofer et al., 2005; Muradian et al., 2010; Wilson and Hart, 2000), while other studies have found that financial compensation plays little role in adoption decisions (Greiner and Gregg, 2011; Mzoughi, 2011).

1.2.2. Social and cultural constraints

While much of the literature on the adoption of specific practices tends to focus on economic constraints, social and cultural norms also factor into decision-making (Nassauer et al., 2009; Schultz et al., 2007). These norms are created and distributed at different scales (e.g., household or community) and through different means (e.g., social networks or institutions).

Studies of sustainability transitions highlight the role of norms in farmers' management decisions (Burton and Paragahawewa, 2011; Meek, 2015; Padel, 2001; Willock et al., 1999, Trevisan et al. 2016). As an example, Sutherland and Darnhofer (2012) found that the cultural – or normative – preference for 'tidy fields' can be a barrier to the adoption of beneficial practices, such as cover cropping, which may make a field look 'messy.' Thus, the incongruence of agroecological practices with dominant social or cultural norms within a particular farming community can inhibit the transition between agricultural regimes. Analyzing the composition of farmers' social networks and organizations, and the norms and practices they promote, can highlight important social and cultural constraints to agroecological transition.

1.2.3. Knowledge-related constraints

Because agroecological practices require a complex understanding of the local agroecosystem, transitions can be knowledge-intensive endeavours (McCracken et al., 2015). Knowledge must include not only an understanding of crop species, variety selection, and specific management practices, but also an ability to adapt these to changing environmental and market conditions.

While most farmers have a deep understanding of their local agroecosystem, knowledge gaps can sometimes arise from migration; from the loss of traditional knowledge with the industrialization of agriculture (Timmermann and Félix, 2015); or from the impact of climate change on local growing conditions (Altieri et al., 2015). Accordingly, many studies cite a lack of knowledge or access to extension services as a key constraint to agroecological transition (Holt-Giménez, 2006; Schmitt Filho et al., 2013; Wittman and Blesh, 2017).

During the Green Revolution, the model for disseminating knowledge to farmers was driven primarily by crop science researchers and extension agents (Roling and Wagemakers, 2000). In contrast, the agroecology literature highlights the need for a more complex approach to knowledge development and dissemination that includes local, traditional and/or farmer-generated knowledge (Altieri, 2009; Méndez et al., 2013; Warner, 2008, Farley et al., 2015). Smallholder farmers' production decisions, knowledge and marketing skills are closely linked to the social relations within and between households. Therefore, factors that reduce farmers' abilities to create, acquire, enhance, utilize and transfer knowledge through networks could be a significant constraint for farmers interested in adopting agroecological practices.

1.2.4. Biophysical constraints

Landscape-scale characteristics, such as soil type, climate, biodiversity, and water quality, interact with farm-level

management decisions to drive attributes of different agroecosystems, such as farm-scale biodiversity or soil organic matter levels. Farmers with limited resources can be more vulnerable to environmental variability and shocks when they lack the capacity to build soil fertility or maintain biodiversity to control pests and diseases. For some farmers located in marginal biophysical environments, a lack of resources can cause a cycle of soil fertility degradation with maladaptive feedbacks that reduce yield and crop nutrient uptake, household income, and dietary quality (e.g., Vanek and Drinkwater 2013, Alvez et al., 2014). Agroecosystems experiencing cycles of degradation are resistant to transformation towards more resilient or sustainable configurations (Cabell and Oelofse 2012), representing a biophysical constraint to the adoption of low-input, agroecological management.

1.3. The evolution of agroecology in Brazil

Discussions of agroecology in Brazil emerged from the convergence of social and environmental struggles in opposition to the negative consequences and unequal distribution of the benefits of agricultural industrialization. Beginning in the 1970s, citizens mobilized against environmental degradation caused by industrialization, particularly in relation to a perceived overuse of agrichemicals, deforestation, erosion, surface and groundwater contamination (Wezel et al., 2009). Environmental movements began to promote alternative agricultural models, such as organic agriculture and agroecology. During the same period, social movements originating among smallholder farmers were pushing back against the concentration of land by agrarian elites, and the broader social inequalities stemming from agricultural modernization (Wolford 2010). These environmental and social struggles merged in the 1990s to gain a relatively strong institutional presence for agroecology in Brazil, including national rural extension services and research organizations (Petersen et al., 2012, Alvez et al., 2014, Schmitt Filho et al., 2013; da Costa et al., 2017).

The national law regulating organic certification in Brazil was developed based on agroecological principles including elements such as "the cultural integration of rural communities, social equity, the economic valorization of family production, [in addition to] respect for natural resources" (Abreu et al., 2012 p. 152). Building on these principles, the 2012 release of the National Policy for Agroecology and Organic Production (*Política Nacional de Agroecologia e Produção Orgânica, PNAPO*) exemplifies the incorporation of agroecology into government discourse and action. The PNAPO "seeks to optimize the integration between production capacity, the use and conservation of biodiversity and other natural resources, ecological equilibrium, economic efficiency and social justice" (Decree No. 7.794, 2012).

Brazil has operationalized agroecological practices through certification programs, including Participatory Guarantee Systems (PGS) (Abreu et al., 2012). PGS certification allows peer-to-peer certification. This means that farmer groups are able to monitor production practices within their network according to agroecological standards set out by PGS program administrators. In

Table 1: Rede Ecovida certification standards. DOI: <https://doi.org/10.1525/elementa.248.t1>

<u>Required practices:</u>
Farmers must reduce dependency on external inputs (e.g., purchased fertilizers or pesticides);
Water sources must be protected by riparian buffers;
At least 20% of native forest must be preserved on the property;
Biodiversity must be increased (or maintained);
The use of purchased inputs (e.g., organic pesticides or fertilizer) should not be used if a pest or weed problem can be addressed through appropriate soil or fertilization management such as cover cropping, crop rotation or the use of straw mulch;
Only organic seeds may be used;
<u>Encouraged practices:</u>
Erosion prevention techniques to protect soil;
Agroforestry;
Integration of animal production and vegetable production systems;

Source: Rede Ecovida de Agroecologia, 2004.

comparison to third party auditors, PGS can have lower transaction costs, and can be more accessible for poor or smaller-scale farmers (Barrett et al., 2012). Brazil had the highest number of producers – 2171 farmers – certified through PGS programs (IFOAM PGS Statistics Map, 2016).

In Brazil, the *Rede Ecovida* is a PGS system that facilitates agroecological and organic certification. The *Rede Ecovida* is a decentralized agroecology network that brings together farmers, suppliers, extension agents and consumers in regional groups with the intention of “organizing, strengthening and consolidating” agroecology among family farmers (Rover, 2011, p. 59). The certification standards set out by *Rede Ecovida* include practices and principles that align with the concept of agroecology as a ‘system redesign’ (**Table 1**). In addition to its sustainability goals, the *Rede Ecovida* also calls for gender and generational equality in decision-making, the valorization of farm labour and cooperation within its participatory process, among other social objectives (Rede Ecovida de Agroecologia, 2004).

1.4. The PNAE and agroecology

The PNAE is a national school meals program that began in 1955 and is managed and funded at the federal level by the Ministry of Education to improve the food security and learning capacity of children in public schools (Rocha, 2009). Subsequently, the Brazilian government introduced a local procurement mechanism requiring that 30 percent of funding to each municipality for school meal programs be used to acquire food from family farmers from within the same municipality (Law No. 11.947, 2009). This requirement was justified in part by research underscoring the contribution of family farmers to domestic food security (IBGE, 2006; INCRA/FAO, 2000). Under this initiative, farmers can access contracts with a quota limit of R\$20,000 per year, per farmer (which is almost double the current annual minimum wage of R\$ 10,560). Beyond the requirement of provision from local family farmers, the government also introduced explicit incentives – including a 30 percent price premium

and priority access to PNAE contracts – to increase the provision of certified organic and agroecological foods within the school meal program (Law No. 12.512, 2012; Resolution No. 26, 2013).

1.5. Agroecology in Santa Catarina

Santa Catarina is a relatively small state located in southern Brazil, with a highly diversified farming landscape. A mountain range running from north to south divides the high plains to the West from the coastal plains along the Atlantic Ocean. Santa Catarina has among the highest levels of education and literacy in Brazil (IBGE 2013; SEBRAE 2013). Similar to the national average, 85% of farming establishments are categorized as family farms with an average farm size of 28.8 hectares (IBGE, 2006).

In 2006, Santa Catarina had the 3rd highest percentage of certified organic/agroecological producers in the country (IBGE, 2006). As of April 2016, the number of certified producers has more than tripled, with 909 certified organic/agroecological family farms in Santa Catarina (5 percent of family farmers in the state) (Ministério da Agricultura, 2016). Several social movements in Santa Catarina actively promote the use of agroecological practices among family farmers, including the Landless Rural Workers Movement (*Movimento dos Trabalhadores Rurais* – MST), the Rural Women’s Movement (*Movimento das Mulheres Campesinas* – MMC) and the Small-scale Farmers’ Movement (*Movimento dos Pequenos Agricultores* – MPA). Other non-governmental organizations (NGOs) – and in particular the Agroecological Farmer Association of the Foothills of Santa Catarina (AGRECO) and *Rede Ecovida* (Ecovida network) – support agroecological transition in Santa Catarina through marketing cooperatives, credit cooperatives and knowledge-sharing and extension support (Tagliari, 2006, Schmitt Filho et al., 2013, Alvez et al., 2014, Schröter et al., 2015).

Santa Catarina also exhibits a higher proportion of purchases within the PNAE from family farmers than other states, with approximately 88 percent of municipalities in Santa Catarina purchasing food from family farmers for

the PNAE. Santa Catarina has the second highest national rate (42 percent) of federal education ministry funding used for the provision of food from family farmers (FNDE, 2014), which exceeds the 30 percent required by law. Although current summary data on extent of organic procurement is not available, a survey from 2010 (before the explicit PNAE incentives for agroecology were introduced) found that 17.7 percent of municipalities in Santa Catarina that sourced food from family farmers also reported purchases from certified organic farmers (da Silva and de Sousa, 2014).

2. Methods

To investigate whether and how participation in the PNAE mitigate constraints to the adoption of agroecology for family farmers in Santa Catarina, we conducted a qualitative field study between May and August 2015 in three municipalities: Lages, Curitibanos, and Correia Pinto (**Figure 2**). These municipalities were purposively selected because they are in a region that has two main farmer groups selling to the PNAE: one affiliated with an NGO network specializing in agroecology extension and organic certification, and a second comprised of non-certified farmers organized through municipal Secretaries of Agriculture and Education. Participant selection was facilitated through PNAE administration in Lages and through an extension agent working with *Centro Vianei* (an agroecology extension NGO) in Curitibanos and Correia Pinto.

Our sampling strategy was designed to capture the experiences of farmers participating in the PNAE programs in municipalities with similar climatic

conditions (the *Planalto Serrano* has hot summers, and cool, wet winters), agricultural production systems, and demographics. We initiated our fieldwork by conducting 18 key informant interviews with a broad range of actors: academics, government officials, extension agents, NGO workers, and administrators of the PNAE in each of the three municipalities. These interviews helped to situate the research in the local economic, demographic, and political context, and to purposively select the sample of farmer participants. Then, we conducted 38 semi-structured interviews with certified agroecological (N = 14), in-transition (N = 2), and non-certified farmers (N = 22) selling to the PNAE, each lasting 45–90 minutes. The interview instrument is available in supplementary material (Text S1).

Figure 3 shows our interview sample size compared to total population of PNAE participants in each study location. The number of farmers interviewed in each municipality was decided iteratively when data saturation was achieved (Marshall 1996). All interviews were recorded, transcribed, and coded using NVivo (QSR International Pty Ltd 2015). Descriptive statistics were tabulated and plots created using R Software (R Core team, 2015) using packages 'dplyr' (Wickham and Francois, n.d.), 'ggplot2' (Wickham, 2009) and 'wesanderson' (Ram and Wickham, 2015).

3. Results: Cultivating agroecology

In what follows, we outline the trends related to differences in production systems between certified, in-transition, and non-certified farmers. We outline the most common constraints related to adoption of agroecological practices,



Figure 2: Study site locations. Study site locations in the highlands – Curitibanos, Correia Pinto and Lages – are in the centre of Santa Catarina. DOI: <https://doi.org/10.1525/elementa.248.f2>

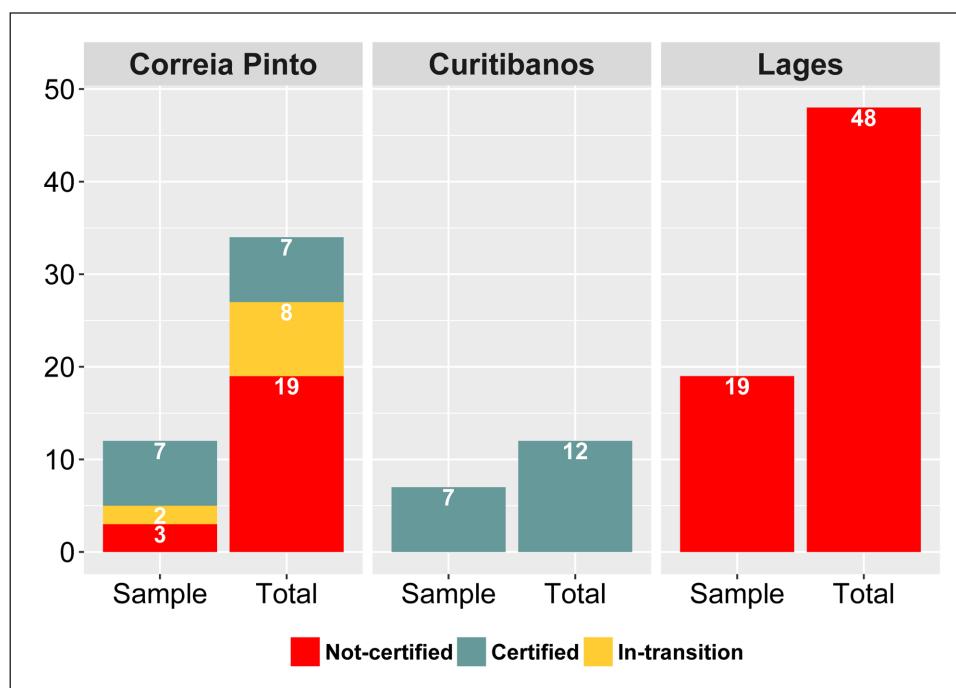


Figure 3: Interview sample size compared to total PNAE participants in each municipality. Plots show the distribution of different sample participants in each category (noncertified, certified and in-transition) by municipality. The sample size and distribution of sample participants is shown in the left bar of each plot. The total number and distribution of PNAE participants in each municipality is in the right bar. DOI: <https://doi.org/10.1525/elementa.248.f3>

Table 2: Characteristics of farms participating in the PNAE. DOI: <https://doi.org/10.1525/elementa.248.t2>

	All farms*	Non-certified	Certified	P-value**
Farm size (ha)	19.9(2.9)	25.1(4.3)	12.8(4.3)	0.036
Age of farmer	48.5(1.8)	49.5(2.4)	47.1(2.8)	0.507
Area in horticulture crops (ha)	0.63(0.1)	0.52(0.1)	0.78(0.1)	0.109
Area in annual crops (ha)	3.79(1.2)	5.2(1.6)	1.8(1.9)	0.175
Pasture area (ha)	5.1(1.3)	5.9(1.8)	3.9(2.1)	0.488
Farmers that do not use agri-chemicals on any area in production (%)***	32.0	13.6	56.3	0.005

*Sample size was 38 farmers: 22 non-certified; 14 certified; 2 in transition (certified and in transition were combined for analysis).

**Student's t-tests comparing non-certified and certified farms; Chi-square test for % farmers not using chemical inputs.

***All values are means (standard error), except for percent agri-chemical use.

and discuss the role of the PNAE as a price-differentiated market. We then discuss the central role of agricultural networks, including extension agencies, suppliers and farmer organizations, in the creation and distribution of knowledge, and the social norms that facilitate the use and certification of agroecological practices through the *Rede Ecovida*.

3.1. Characterization of farmers participating in the PNAE

The mean farm size for all participants was 19.9 hectares (ha) (Table 2). Most farms included a mixture of annual crops (typically field crops such as corn, soybeans, or dry beans), horticulture crops (vegetable production), fruit trees, livestock, dairy, and woodlots. Many of the farmers surveyed indicated that

they previously only grew vegetables for household consumption, but the PNAE program – with its specific market for vegetable crops on the school lunch menu – provided an incentive to expand and commercialize vegetable production.

There were no differences between non-certified and certified farms in terms of the average age of the primary farmer, or area of the farm in pasture (Table 2). Non-certified farms were double the size of certified/in-transition farms (25 v. 13 ha; $P = 0.036$); however, farmers who were certified or in-transition tended to have larger areas devoted to horticulture production (0.8 ha) compared to non-certified farmers (0.5 ha), although the difference was not statistically significant.

Certified farmers in this study tended to only certify their vegetable fields. *Rede Ecovida* certification does not

require certifying the entire farm, although certified and non-certified areas of the farm must be separated. Even so, a significantly greater proportion of certified farmers did not use any type of agrichemical input on their farm compared to non-certified farmers (9/16 farmers v. 3/22, respectively; $P = 0.0005$). Of the certified farmers, 43 percent cultivated certified vegetable crops, but did not seek certification for annual crops such as corn or soybeans. Generally, farmers indicated that growing annual field crops without agrichemicals was not worthwhile as the margins on production are too low. One farmer said: "At first we used to plant corn and beans to sell, [but] the property is small. These days no one can survive with corn and beans, you have to switch to vegetable production" (certified farmer, Curitibanos).

3.2. Economic constraints to adoption

3.2.1. Increased labour requirements

Costs associated with an increase in labour – demands on family labour or additional costs for hiring wage labourers – are a central concern for farmers using agroecological practices. In this study, three quarters of certified and in-transition farmers said that labour demands for agroecological production are higher relative to their experience when using conventional methods. Responding to the difficulties of transition, one farmer said:

We learned what [organic practices] we needed to use, but it was labour that was lacking... many times we knew what we had to do, but we couldn't do it in time. So, the major difficulty is labour (certified farmer, Curitibanos).

In light of these demands, labour supply can become a constraint: "Labour is difficult. If it weren't for family, there isn't any [labour]. [Hiring] a wage labourer is difficult" (non-certified farmer, Lages). Eighty-six percent of non-certified farmers and 81 percent of certified and in-transition farmers reported that they do not have sufficient labour on their farm. Further, 68 percent and 81 percent, respectively, said that finding non-family labour is difficult.

In a discussion about current challenges in rural areas, one farmer spoke of the exodus of youth from family farms into cities: "Family agriculture today, if we could keep our children in the *campo* [countryside] it would be wonderful. The youth are leaving the farms for the city to look for better services, better things, because the *campo* doesn't have this" (non-certified farmer, Lages). Similar sentiments regarding youth migration and low availability of farm labourers were expressed repeatedly across all locations. Therefore, despite premium prices that could potentially offset increased labour requirements, a lack of labour availability remains a constraint to most participants.

3.2.2. Concerns about yield

When asked about the challenges of using agroecological management practices, 31 percent of the non-certified

farmers highlighted their concern about reduced yields during – or even after – transition to agroecological production, as well as some concern about the quality of certified products. For example, in explaining the differences between agroecological and conventional production, one farmer said:

It produces less, it takes more time to grow and it requires a lot of soil amendments... if you don't work the land [the crops] will take a long time to come, there will be some that don't develop, so it is more difficult to produce (non-certified farmer, Lages).

This comment demonstrates concerns about lower yields (production), but also reflects the perception that organic or agroecological production requires more labour. A few farmers spoke of yields dropping during the transition phase, but improving after a couple of years. Similarly, others remarked that yield reductions could be avoided by improving soil quality (e.g., using organic amendments) or increasing labour. For example, one farmer said:

Organic produces the same as with chemicals, at times even better...it's just that you have to know how to plant with [organic] fertilizer and treatments, you have to do more intensive treatments and more frequently (certified farmer, Curitibanos).

3.3. Does the PNAE mediate constraints to agroecological transition?

One hypothesized mechanism to support a transition to agroecological practices is to provide price premiums for certified products to offset actual or perceived increases in costs or reduced yields. The PNAE offers financial compensation for organic and/or agroecological practices via price premiums. We evaluated how important the PNAE is to farmer livelihoods, and whether the PNAE's price-premium is unique compared to other marketing opportunities in the region.

3.3.1. Access to a price differentiated market

All of the certified farmers in this study ($n = 14$) received the standard 30% price premium for agroecological production from the PNAE program. This represented an incentive for some farmers because a price-differentiated market outside of PNAE for certified farmers was small or non-existent in the study locations, and only a few farmers were able to access regional or national markets through cooperative marketing mechanisms. For example, a farmer in Lages who used to use agroecological practices quit doing so after finding it hard to sell her products. She noted: "There wasn't the [PNAE]... there was nowhere to sell." Two extension agents working with the Secretary of Agriculture in Lages corroborated the farmer's concerns, expressing that the only place within the city to sell certified produce was the supermarket – a market largely accessible only to large-scale producers. According to

these agents, the PNAE was unique in offering a price premium that was accessible to small-scale family farmers. In Curitibanos, farmers and extension agents expressed that the only places to sell certified goods were public procurement programs and farmers' markets. The ability to receive a price premium in farmers' markets was varied. Some part of this is due to the absence of consumers who were willing or able to pay for premiums. In the words of one farmer in Lages:

Organic is like this... you arrive at the farmers' market, you will see the products there... But [the customer] will say "No, we want this nice one here" but you respond, "Sir, this one here is not organic", and the price is the same... and [the customer] will say "But this is somewhat ugly, we will take this [non-certified] one here (non-certified farmer, Lages).

This example illustrates a perceived reluctance on the part of consumers in the region to purchase certified products even when they are the same price as non-certified products. An extension agent with *Centro Vianei*, an NGO focused on agroecological practices in Lages, said "...in general at farmers' markets the farmers don't receive more for certification. Worse than this, they sell their products at a lower price than non-certified products being sold at the supermarket." Likewise, in response to a question asking where he can sell certified products for a premium, one farmer said "I think it is mostly the PNAE... because at the fruit vendor... they do not like to pay the premium" (in-transition farmer, Correia Pinto). These quotations illustrate how the PNAE represents a unique marketing opportunity for farms given the absence of alternative markets offering differentiated prices for certified products.

3.3.2. Structural limitations to increased demand for agroecological production

While the PNAE could provide a stable and guaranteed price-differentiated market for farmers looking to transition, in effect, the program has limited available quota, tied to the number of students in beneficiary schools. There are three dimensions related to this relationship that restrict the capacity for the PNAE to function as a mechanism to scale up transitions to certified agroecological production. First, in smaller regions the number and size of available PNAE contracts is limited; more farmers may be willing to participate than the PNAE can accommodate. For example, in Correia Pinto the PNAE supports 3,622 students and approximately 80 percent of the food purchased through the program comes from family farmers.

Because of the relatively low number of enrolled students in the municipality, the total budget available for PNAE contracts does not reach the amount that would be needed for each participating farmer to receive a full PNAE contract. In this municipality, the 34 participating farmers are splitting quota. One farmer said: "The limit is R\$20,000. It's just that we don't reach it... because there are a lot of farmers... Because of this [the quota] has to be divided" (certified farmer, Correia Pinto). According

to 2014 FNDE funding allocations for family agriculture purchases and the reported number of PNAE participants, if split equally among the number of farmers participating in 2015, the quota limit would be approximately R\$8,000 in Curitibanos and R\$6,000 in Lages.

Second, schools receive funding for school meals based on student enrollment, which is irrespective of organic certification. For example, a farmer may receive a R\$5,000 PNAE quota allocation. He or she could sell 5,000 kilos of conventional carrots to a school at R\$1 per kilo, or, with the 30 percent price premium for agroecological production, could sell 3,850 kilos of carrots at R\$1.30. An extension agent with *Centro Vianei* explained this drawback of the current configuration of PNAE contracts:

The only difference in practice of organic and conventional is that [a certified farmer] is going to use up their quota more quickly than a conventional producer, but the money is the same. There isn't a quota for organic and one for conventional. What the municipality can do is... give priority to organic [producers].

This means that while certified farmers may benefit from selling lower quantities of their production at a higher price to the PNAE, to increase income, market diversification would still be required. Third, some farmers outgrow the quota they are eligible for. A farmer in Correia Pinto who has been successful with agroecological production expressed that the PNAE program is important for new farmers during transition: "Yes... with certainty... in the beginning starting with the PNAE is great". However, he explains how he has outgrown the programs: "...We needed to find a market... because the PNAE aren't able to absorb all of our products. So we had to find organic markets on the coast" (certified farmer, Correia Pinto). Conscious of this issue, the PNAE management in Correia Pinto is actively encouraging farmers to find multiple markets in which to sell so that they are not restricted by program quotas.

3.3.3. Importance of the PNAE to diversification of marketing strategies

Interviews suggested that the PNAE and farmers' markets are the dominant marketing channels for certified farmers. Forty-four percent of certified and in-transition farmers indicated that the PNAE constituted more than half of their income, while only 25 percent of non-certified farmers said the same. The number of farmers who indicated that they sell more than half of their agricultural production through the PNAE was the same (44 and 45 percent, respectively) for certified and non-certified farmers.

Farmers markets represented another significant portion of farmers' sales. Seventy-five percent of certified and in-transition farmers reported selling to farmers markets, within which 25 percent reported that more than half of their production goes to farmers' markets. Thirty-two percent of non-certified farmers reported selling to a farmers' market. Several certified farmers

reported selling to farmers' markets in other regions, predominantly coastal markets in larger cities such as Florianópolis, Itajaí or in other states such as São Paulo. Although interview participants indicated that the number and presence of farmers' markets is growing, acceptance of these markets by the local community is slow. Local farmers' markets continue to be predominantly a complementary commercialization stream for farmers, though access to non-local markets is increasingly important. The inconsistency of access to price premiums in other markets is countered by the stable guaranteed premiums with the PNAE.

In summary, the PNAE offers a unique but limited opportunity to participate in a price-differentiated market in the study regions. Farmers generally expressed that PNAE is an important commercialization stream, however, demand constraints within the program limit the extent to which farmers may benefit from the mediated market incentives. Although these economic factors do affect some of the structural constraints farmers face, looking at the broad differences between certified and non-certified farmers suggests that the economic factors alone do not support transition. As demonstrated in the following section, the composition of one's network, including suppliers, other farmers, and distributors are critical factors supporting transitions due to the facilitation of knowledge, skills, and resources necessary for shifting to agroecological production.

3.3.4. Agricultural networks and knowledge exchange

For study participants, reducing social, cultural and knowledge-related constraints was closely linked to agricultural networks. Regional agroecology networks included producers, suppliers, distributors, extension agencies and other organizations that are working to support agroecological production. Farmers articulated how these networks facilitate the sharing of information, knowledge and skills and how they foster social and cultural norms that support agroecology.

All farmers interviewed reported being involved in at least one association. However, there was a clear distinction between certified and uncertified farmers in terms of the type and extent of participation in associations. The non-certified farmers typically participated in 1–2 organizations, the majority of which did not focus on agroecological production. All 19 non-certified farmers in Lages participate in ACRO – a network of rural farmers' associations. When asked what benefits they derive from ACRO, many expressed that it is primarily an equipment-sharing cooperative with no affiliation with agroecological principles or extension support.

Certified and in-transition farmers reported participating in 1–5 social movements or organizations, with the average 2.75 per farmer. Of these, the majority were social movements or organizations dedicated to agroecology as not just a set of practices, but also a philosophy. These included a diverse array of agroecologically-focused distribution cooperatives, seed suppliers, credit cooperatives, unions and farmers' organizations. This participation facilitated sales, input supply and knowledge acquisition.

The role of agricultural networks is evident through the differences in agroecological knowledge acquisition among farmers. Fifty percent of certified/in-transition farmers spoke about a lack of knowledge (or access to knowledge) of agroecological practices and standards as a difficulty during their transition. Non-certified farmers expressed a similar concern, saying: "The difficulty is knowledge that we don't have, you see... I don't have the knowledge, so, how could we do it?" (non-certified farmer, Lages). Therefore, understanding the different ways that farmers access information related to agroecological production is important.

Another distinction between certified and non-certified farmers related to access to extension services. All certified farmers reported receiving agroecological extension services from either civil society (e.g., *Centro Vianei*) or the government (e.g., extension funded by the Ministry of Agrarian Development). Of those who are not certified, only 18 percent reported receiving support from agroecological extension agencies from either civil society or the government. This is not surprising as those who are not certified or in-transition would be unlikely to access agroecological extension. However, many of the farmers who are not certified did not know that there are such services available. For example, *Centro Vianei* supports all the certified farmers in Curitibanos and Correia Pinto but only 2 farmers in Lages reported attending a seminar or course offered by *Centro Vianei* despite the headquarters being located in Lages.

Another form of knowledge acquisition and exchange is via other farmers – early adopters – who demonstrate success and share their experiences with farmers in their networks. Considering that there are no farmers in Lages who have transitioned to agroecological practices, an extension agent in the municipality identified a lack of 'example farms' as a constraint:

Here there isn't much information [about agroecological practices], there aren't many things promoted, so we are partly in doubt. There doesn't exist [someone thinking] "Oh, that producer figured it out, got good results, I'm going to ask him what he did"... we don't have many experiments in this region that could be publicized (extension agent, Lages Secretary of Agriculture).

Certified farmers highlighted role models that help gauge the risk and reward of transition. One farmer in Correia Pinto learned about agroecological practices through his son who graduated from an extension services program and has encouraged others to pursue agroecological certification. He has also created a distribution cooperative for certified farmers in his area. Regarding perceptions of yield changes, another farmer viewed a neighbor's experience as motivational for transition:

It's our third year. Last year it produced well and this year it will be even better! We know of an area where a guy has been [agroecological] for eight years... He planted in the same area and each

time it produces more... The other guys used to say "after five years it won't produce anymore"... but it is the contrary... and mine is the also the contrary (certified farmer, Curitibanos).

For these participants, farmer-to-farmer knowledge sharing by early adopters as well as formalized extension services catering to agroecological production were important factors in adoption.

Farmers' access to inputs is another example of the way that networks can facilitate transition. About a quarter (5/22) of non-certified farmers expressed concerns over accessing certified organic inputs such as fertilizers or pest management products. For example, three separate interviews in Lages indicated:

I would like if [organic crops] produced better than [crops with chemicals]... what we plant here grows better than [conventional crops], if you have a good fertilizer. But, where will you get this good fertilizer? (non-certified farmer, Lages).

There are things that you need but you don't have; where will you look in order to produce organically? Because to produce organically is a lot of procedure, it is not just to produce organically... and you don't have a [place] specializing in organic inputs that can be used if you get a pest. We think that this is the biggest barrier (non-certified farmer, Lages).

Our biggest problem is seeds... because organic production, right from the seed it has to be organic (non-certified farmer, Lages).

While non-certified farmers felt that certified organic fertilizer and pest control inputs were not available, many certified and in-transition farmers noted that they sourced products from *Centro Vianei* and *Ecoserra* – organizations that were centrally located for all participants. Statements about lack of inputs are thus likely due to a lack of awareness or connection to local sources rather than a lack of availability in the region. This illustrates the role of social and institutional networks for connecting farmers with agroecological resources they may otherwise not know about – both locally and non-locally. In sum, the composition of farmers' agricultural networks and their access to resources (notably knowledge and inputs) are related to their certification status. Certified farmers tend to have more diverse participation in organizations and social movements that support greater access to both formal and informal knowledge-sharing and to material resources needed for organic production.

4. Discussion and Conclusion

Our study was located in a region with a significant opportunity for transition, with a strong presence of civil society actors working in support of agroecological production and the institutionalization and operation

alization of agroecological practices at the national and regional levels. This exploratory examination of the potential of a public food procurement program to foster transitions toward agroecological practices has revealed several logics and outcomes driving agroecological transition.

Our primary finding is that even though the PNAE is instrumental in creating demand and paying premiums for certified agroecological production, its influence is limited without the enabling force of agricultural networks of suppliers, non-governmental extension services and farmers' associations. Because agroecological practices are not dominant in the study regions, networks are critical for accessing inputs specific to agroecological production, including seeds, organic amendments and/or knowledge. It is critical for farmers to be able to tap into broader agroecological networks that operate through organizations like *Rede Ecovida*, since it appears that finding organic inputs through conventional networks is restricted.

Second, considering regional labour shortages, farmer concerns about the increased labour demands associated with agroecological production practices present a considerable constraint. Labour was the major economic constraint in the transition to agroecological production, whereas concerns over reduced yields existed among some farmers, but not the majority. The trend of youth leaving rural areas in search of non-farm employment may well exacerbate this issue. Finding ways to retain youth on family farms through income or technological supports may be a way to support agroecological production. As such, future research could look at farmers' perceptions of labour demands and investigate labour-saving technologies that remain aligned with agroecological principles.

Third, in regards to production systems, the PNAE is particularly suited to support smaller-scale certified production systems. Results showed that certified farmers were almost half the size of non-certified farmers, and they had a greater reliance on PNAE for their income. This is important because farm size is likely to have an inverse relationship with the proportionate contribution of the PNAE to farmer income (i.e. dependency on PNAE will decrease as farmers' production exceeds the quota limit available to them – as many already do). Therefore, the relative contribution of the PNAE to a farmer's livelihood is likely higher for small farms, thus exhibiting greater influence on small farmers' management decisions. This is positive for very small farms, but raises concern over how the PNAE can be influential for family farms whose production greatly exceeds PNAE limits. In this case, it may not be economically feasible to change management practices if the benefits of the price-differentiated market of the PNAE constitute only a small portion of total farm income.

Finally, the production systems exhibited in this study represent only a partial agroecological transition. The ability for farms to be partially certified (i.e. in vegetable crop areas for school markets, while annual field crops and pasture remain non-certified) may enhance participation in price-differentiated markets, and improve the accessibility of organic foods to urban consumers,

but conversely may hinder a 'system redesign' version of agroecological transition involving significant scaling up of agroecological land management. Our analysis thus highlights how structural constraints such as labour requirements, access to markets, knowledge and support networks may limit the options available to farmers who might otherwise consider a transition to agroecological practices. These findings can serve as a springboard for further research into the ways that targeted public procurement programs can influence the adoption of agroecological practices in the pursuit of mitigating the socioeconomic and environmental impacts associated with industrial farming systems.

Data Accessibility Statement

The semi-structured interview guide used in farmer interviews is available in supplementary material. Transcripts of interviews are not made publicly available to protect participant confidentiality.

Supplemental File

The supplemental file for this article can be found as follows:

- **Text S1.** Semi-structured interview guide. DOI: <https://doi.org/10.1525/elementa.248.s1>

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- Field data collection: JG
- Analysis and interpretation of data: JG, JB, HW
- Drafting the article and revising it critically for intellectual content: JG, JB, HW
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