

## Exploring barriers to the agroecological transition in Nicaragua: A Technological Innovation Systems Approach

Katharina J.F. Schiller, Laurens Klerkx, P. Marijn Poortvliet & Wendy Godek

**To cite this article:** Katharina J.F. Schiller, Laurens Klerkx, P. Marijn Poortvliet & Wendy Godek (2020) Exploring barriers to the agroecological transition in Nicaragua: A Technological Innovation Systems Approach, *Agroecology and Sustainable Food Systems*, 44:1, 88-132, DOI: [10.1080/21683565.2019.1602097](https://doi.org/10.1080/21683565.2019.1602097)

**To link to this article:** <https://doi.org/10.1080/21683565.2019.1602097>



© 2019 The Author(s). Published with license by Taylor & Francis Group, LLC.



Published online: 14 Apr 2019.



Submit your article to this journal [↗](#)



Article views: 6424



View related articles [↗](#)







View Crossmark data [↗](#)



Citing articles: 21 View citing articles [↗](#)

# Exploring barriers to the agroecological transition in Nicaragua: A Technological Innovation Systems Approach

Katharina J.F. Schiller <sup>a</sup>, Laurens Klerkx <sup>b</sup>, P. Marijn Poortvliet <sup>c</sup>,  
and Wendy Godek <sup>d</sup>

<sup>a</sup>Knowledge, Technology and Innovation, Knowledge, Technology and Innovation Group, Wageningen University and CIAT Nicaragua; <sup>b</sup>Knowledge, Technology and Innovation, Wageningen University; <sup>c</sup>Strategic Communication, Wageningen University, The Netherlands; <sup>d</sup>International Center for Tropical Agriculture (CIAT), Nicaragua

## ABSTRACT

Latin America has historically been a vanguard of agroecology. In Nicaragua, an agroecological transition is occurring, with three decades of building a groundswell based on the farmer-to-farmer movement and the recent institutionalization of agroecology in national law. Yet, problems remain with agroecology's diffusion. We introduce the Technological Innovation Systems approach to examine systemic barriers to the agroecological transition and cycles of blockages caused by barriers' interactions. Based on qualitative data from north-central Nicaragua, we find the main barriers hindering the agroecological transition include weak guidance of the search for agroecology, insufficient capacities and quantities of resources, and lacking market development. Beyond the Nicaragua case, the analysis points at the importance of using socio-technical systems analysis to better understand and address the root causes behind issues blocking national agroecological transitions.

## KEYWORDS

Sustainability transitions; socio-technical systems analysis; Latin America; agroecology; agricultural innovation systems

## Introduction

Agroecological farming systems, which utilize ecological principles for the design and management of resilient, sustainable, and productive farms, have been identified as promising alternatives to the dominant input-intensive agro-industrial production model (FAO 2015). While agroecology<sup>1</sup> started as a grassroots movement (Altieri and Nicholls 2012), and its initial push came from social movements (Tittonell et al. 2016), it has increasingly become part of national policies (Gonzalez de Molina 2013; Gliessman 2017). Agroecology's institutionalization in national policies of some countries can be seen as a next step in the transition of the agri-food system to more sustainable modes of production and consumption (Bacon et al. 2014), also referred to as the

**CONTACT** Katharina J.F. Schiller  [katharina.schiller@wur.nl](mailto:katharina.schiller@wur.nl)

The authors confirm that this manuscript has not been published elsewhere, nor has it been submitted for consideration of publication elsewhere.

Color versions of one or more of the figures in the article can be found online at [www.tandfonline.com/wjsa](http://www.tandfonline.com/wjsa).

© 2019 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.

agroecological transition (Duru, Therond, and Fares 2015; Ingram 2017; McCune et al. 2016; Meek 2016; Ollivier et al. 2018; Teixeira et al. 2018).

Particularly in Latin America, “the expansion of agroecology [...] initiated an interesting process of cognitive, technological, and socio-political innovation [...] Thus, a new agroecological scientific and technological paradigm is being built in constant reciprocity with social movements and political process” (Altieri and Nicholls 2017, 235). This has led to great scholarly interest in processes of agroecological transition in Latin American countries, as evidenced by this journal’s 2017 Special Edition (Gliessman 2017). The agroecological transition is a complex, multi-level process involving interactions and co-evolutionary alignments between the focal technology – agroecology – and associated bio-physical, social, political, economic, and institutional aspects (Blesh and Wolf 2014; Gaitán-Cremaschi et al. 2019; Pant 2016; Piroux et al. 2010). Hence, the agroecological transition may be described as the formation and development of a new agroecological innovation system within the dominant incumbent agricultural innovation system (based in conventional agriculture).

While authors have identified separate technological, political, and financial lock-in factors that may support or hinder the agroecological transition, such as a lack of knowledge about, political will to push for, or financing opportunities to support agroecology (Altieri and Nicholls 2008; Altieri and Nicholls 2012; Silici 2014; Wibbelmann et al. 2013), there is only limited analysis on how these factors interact. This paper addresses this gap by analyzing the development of the agroecological system in Nicaragua through the lens of technological innovation systems (TIS), defined as “a set of networks of actors and institutions that jointly interact in a specific technological field and contribute to the generation, diffusion and utilization of variants of a new technology” (Markard and Truffer 2008, 611).

TIS analysis has been applied to explain the development of new technologies and the obstacles they face in transforming incumbent systems in the development and diffusion of sustainable innovations.<sup>2</sup> Focusing on environmental sustainability, TIS analysis was originally applied to new energy technologies (Blum, Bening, and Schmidt 2015; Musiolik and Markard 2011; Wiczorek et al. 2013). It has been used in the agricultural context to analyze precision agriculture technologies (Busse et al. 2015; Eastwood, Chapman, and Paine 2012; Garb and Friedlander 2014), innovations in the dairy sector in Ethiopia (Kebebe et al. 2015), the mycorrhiza value chain in France (Angeon and Chave 2014), and rainwater harvesting techniques in Jordan (Sixt, Klerkx, and Griffin 2017). Recently, the agroecological transition in Rwandan agriculture was analyzed using a socio-technical systems lens (Isgren and Ness 2017); related transition management theories have been used to explore the Nepalese agricultural sustainability transition (Pant et al. 2014).

In this article, we use TIS analysis to go beyond a description of the development of agroecology in Nicaragua. We identify factors supporting or limiting the agroecological transition and interactions between factors that create vicious cycles, further blocking the diffusion of agroecology. Nicaragua is especially pertinent for this analysis because agroecology has a long history in the country, has recently been enshrined in national law, and may be considered in a diffusion stage. The next section introduces the theoretical framework and some reflections on applying TIS analyses in the context of agroecology. Section 3 details methods and Section 4 provides results of the structural-functional TIS analysis of Nicaragua's agroecological transition. Conclusions and contributions to literature are drawn in Section 5, and Section 6 presents a final discussion that reflects on the utility of TIS analyses to furthering our understanding of agroecological transitions.

### **Theoretical framework: Innovation systems analysis**

In recent years, the TIS approach has become a useful tool for creating a holistic understanding of actors and institutions involved in the propagation of innovations (Birner 2012). At the national level, an agricultural innovation system consists of all actors, institutions, and policy settings concerning agricultural production and consumption. As a TIS, the agroecological innovation system (AeIS) is a subset of the national agricultural innovation system. It is composed of the actors, institutions, and policies involved in agroecology. Although this study examines Nicaragua's national AeIS, it is important to note that some national agroecological organizations are linked to the global agroecology movement, and as such form part of the global AeIS (in line with ideas of TIS crossing national boundaries (Hekkert et al. 2007). The following section explains how structural-functional TIS analysis of the AeIS works.

#### ***A structural-functional analysis to give new insights on the agroecological transition***

Innovation systems analysis distinguishes structures, i.e. the elements that make up the system, and functions, i.e. how these elements work in support of the innovation (Wieczorek and Hekkert 2012). The structures of an AeIS can be delineated as actors, institutions, interactions, and infrastructures (see Table 1). To identify issues that hinder the diffusion of agroecology, an innovation systems approach analyzes the way these structures enable innovation in support of a transition towards agroecology by examining the performance of so-called "functions of the innovation system". Seven key functions have been identified in the literature and are explained in Table 2 (Bergek et al. 2008; Hekkert et al. 2007). Systemic problems are related to the

**Table 1.** Structures of technological innovation systems (based on Wieczorek and Hekkert 2012).

Structure	Description
Actors	The “players in the game” (Klein Woolthuis, Lankhuizen, and Gilsing 2005). Includes individuals and organizations, such as farmers, farmer organizations, civil society organizations, government agencies, knowledge and research institutes, financial organizations, and donor organizations.
Institutions	The “rules of the game”. Can be hard (formal institutions, such as policies, standards, and regulations) or soft (informal). Institutions can support innovation processes by enabling space for change, or conversely hinder it through rigidity and close-mindedness.
Interactions	Interactions can help actors e.g. align their visions, leverage resources, and share knowledge. Includes informal interactions between actors or institutions, and formalized interactions such as networks.
Infrastructures	Includes physical infrastructures (e.g. roads, structures, networks, machines, artefacts), financial infrastructures (e.g. subsidies, specific credit lines, financial programs) and knowledge infrastructures (e.g., knowledge, strategic information).

presence (or absence) and quality (or capacity) of each of the structures in contributing to each of the functions (see Table 3) (Wieczorek and Hekkert 2012). Further, systemic problems may have causal relationships and form clusters of so-called blocking mechanisms. These blocking mechanisms may reinforce each other, leading to “vicious cycles” of problems that hinder the further diffusion of agroecology (Weber and Rohrer 2012; Klein Woolthuis, Lankhuizen, and Gilsing 2005). The coupled functional-structural analysis identifies these barriers and aids in pinpointing entry points to support the diffusion of agroecology (Kebebe et al. 2015; Lamprinopoulou et al. 2014).

## Methodology

This research is a qualitative case study analysis of agroecology in Nicaragua. Results are based on field work conducted in northern and central Nicaragua undertaken in 2014 and 2016–18.<sup>3</sup> All field work, including interviews, workshops, and document analysis, was conducted in Nicaragua’s official language, Spanish. Table 4 summarizes the field work events and participants.

A review of scientific and grey literature preceded and accompanied the field study and results analysis period. This data included national policy documents (e.g. GRUN 2011, 2012); newspaper articles (e.g. Herrera 2014); reports from international donors, research centers, civil society organizations, and non-governmental organizations (e.g. Fréguin-Gresh 2017; Fundación Luciérnaga and SIMAS 2010); and peer-reviewed articles on agroecology in Nicaragua (e.g. Godek 2015; González, Salmerón-Miranda, and Zamora 2015; McCune 2016; McCune et al. 2016). Scientific literature was found using keyword searches that reflected the different aspects of this paper: the term ‘agroecology’ or ‘agroecological’ in combination with ‘Nicaragua’, ‘technological innovation systems’, ‘adoption’, ‘scaling’, or



**Table 2.** Functions and diagnostic questions for systemic analysis (Bergek, Jacobsson, and Sandén 2008; Hekkert et al. 2007; Wieczorek and Hekkert 2012; Wieczorek et al. 2013).

Function	Description	Diagnostic questions
F1: Experimentation by entrepreneurs	Entrepreneurs are essential: their role is to turn the potential of new knowledge, networks and markets into concrete actions to generate and take advantage of business opportunities. Experimentation by entrepreneurs refers to not just actors' willingness to experiment with the new technology, but also their ability to do so – which is based on the resources at their disposal. Different types of actors experiment differently: for example, farmers may experiment with agroecological practices on their farm, while market entrepreneurs may experiment with novel value chain arrangements.	Sufficient and suitable actors contributing to diffusion? Amount and type of experiments sufficient?
F2: Knowledge development	Mechanisms of learning are at the heart of any innovation process. Knowledge development involves both experimentation (learning-by-doing) and research (learning-by-searching) (van Mierlo et al. 2010). New knowledge can be created by e.g., farmers through farm experimentation, or in formalized institutional settings such as universities, and further serves to legitimize the use of agroecology. Knowledge exchange is the co-construction of knowledge by actors from different sectors of the TIS, as well as the formalization of knowledge exchange processes (e.g., through networks).	Enough and competent actors involved in knowledge development? Knowledge development sufficiently aligned with actors' needs? Sufficient networks or connections through which knowledge is exchanged?
F3: Knowledge exchange	The processes that lead to a clear development goal for the new technology based on technological expectations, articulated user demand and societal discourse. Guidance of the search is the creation of a clear vision for further development of the technology and involves an understanding of different actors' goals and visions. It is an important factor in aligning actors' visions of how the system is functioning, and how it should move forward. In countries with a centralized political system (such as Nicaragua), this function is heavily dependent on government input.	Do actors and institutions provide sufficiently clear direction for future development?
F4: Guidance of the search	Market formation entails the use of a variety of mechanisms to create demand for the outputs of the new technology (Sixt, Klerkx, and Griffin 2017) – here, agroecological products. The creation of markets facilitates cost reductions and incentivizes entrepreneurs.	Size of market sufficient to sustain entrepreneurial experimentation and innovation? Sufficient financial resources? Sufficient and competent actors? Sufficient physical infrastructure?
F5: Market formation	Resource mobilization – of financial and human resources, knowledge and physical resources – is necessary for TIS growth and intimately linked to actors' alignment along similar goals and their shared visions. New technologies, particularly knowledge-intensive technologies such as agroecology, often have difficulties competing with entrenched technologies (Hekkert et al. 2007).	Do actors, formal and informal institutions sufficiently contribute to legitimacy? How much external resistance is present towards the technology?
F6: Resource mobilization	Innovation is by definition uncertain. The creation of legitimacy reduces uncertainties and counteracts the resistance to change. The (7) creation of legitimacy for agroecology vis-à-vis the dominant conventional agricultural system is of central importance to further diffuse agroecological practices and principles nationwide by securing broad (public) support for agroecology. It helps minimize uncertainties to which actors are exposed, e.g. through supporting market development or enabling a stable regulatory environment (Klerkx, Aarts, and Leeuwis 2010).	
F7: Creation of legitimacy		

**Table 3.** Systemic problems leading to blocking mechanisms (based on Wieczorek and Hekker 2012).

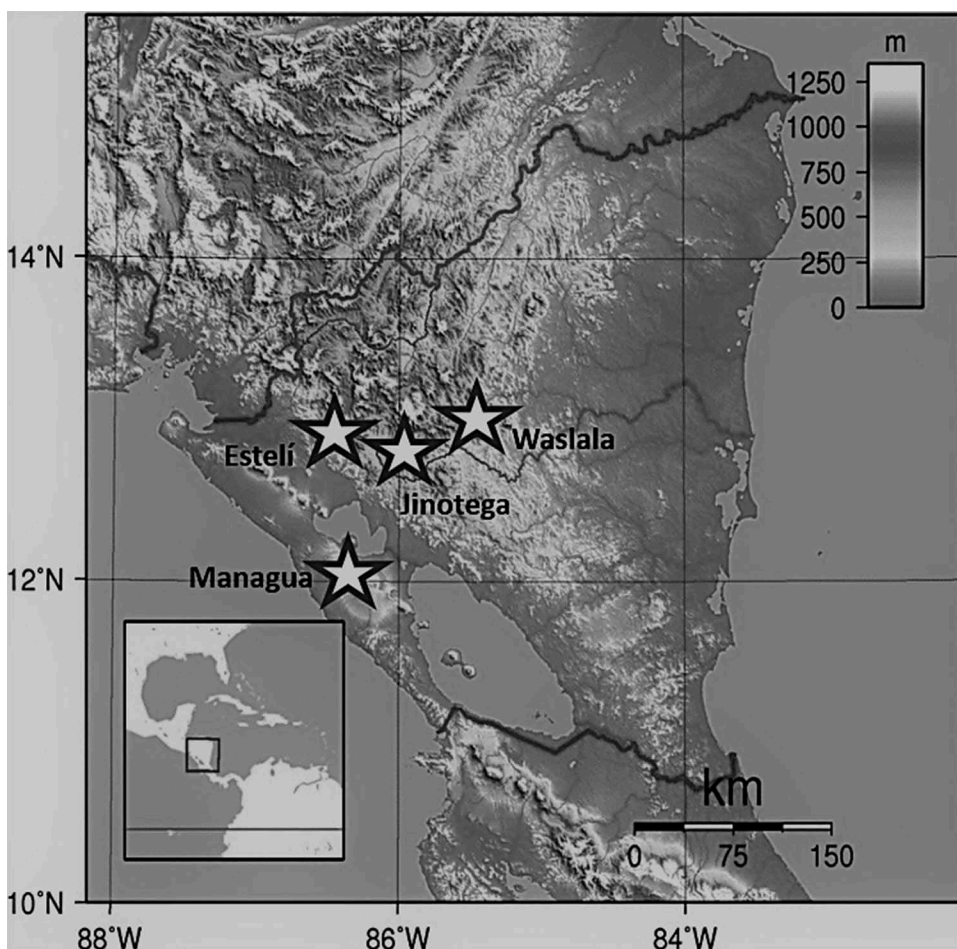
Problem dimension	Actors	Institutions	Interactions	Infrastructures
Presence or absence	Absence of actors	Absence of specific institutions that support the agroecological transition	Missing interactions due to e.g. lacking trust, capacities, differing assumptions	Absence of necessary infrastructures, such as value chains or knowledge exchange
Quality/Capacity	Lacking capacity of actors	Strong institutional problems leading to technological 'lock-in' of conventional agriculture; weak institutional problems hinder innovation concerning agroecology	Strong network problems exist when some actors are erroneously guided by stronger actors; weak network problems hinder interaction and innovation	Lacking quality of infrastructures, e.g. bad roads hindering timely access to markets

**Table 4.** Summary of data collection.

Type of data gathering	Details – respondents from organizations
Semi-structured interviews	4 scientists and extensionists from producer organizations 6 scientists from research and education institutes 2 department managers from government institutions 2 managers from financial institutions 1 scientist from INGO 3 scientists from national NGOs 9 agroecological smallholders
Workshops	2 with agroecological smallholders, total: 27 participants (11 female, 16 male) 1 multi-stakeholder, 8 participants
Farm visits and interviews	9 agroecological smallholders (3 female, 6 male)
Literature review	Scientific literature Grey literature from involved organizations Newspaper articles
Document analysis	Government policies Internal documents from involved organizations

'transition'. The searches were performed in the scientific literature databases SCOPUS, ScienceDirect, Web of Science, and Google Scholar.

To understand the agroecological transition from different perspectives – its implementation at the national (political) level and the rural (farm) level – data was gathered during research in Managua, the capital, and in three rural areas, shown in [Figure 1](#). The rural locations were chosen to represent a variety of agroecological zones (the dry tropics in Estelí and the humid tropics in Jinotega and Waslala) and cropping systems (mixed basic grains and livestock in Estelí, coffee-based systems in Jinotega, and cocoa-based systems in Waslala). Additionally, each area had the presence of an active Territorial Learning Alliances (TLA, also called innovation platforms in the broader



**Figure 1.** Map of Nicaragua with research areas starred (mapsof.net 2014).

literature (Kilelu, Klerkx, and Leeuwis 2013; Schut et al. 2018)) promoting agroecology. To capture as rich a picture as possible, targeted research participants included stakeholders from a variety of groups: agroecological farmers and farmer organizations, national and local CSOs and NGOs, research institutes, educational institutes, and government institutions. Semi-structured interviews were conducted with organizations that work on “bigger picture issues” (e.g. knowledge-sharing or national development programs) in Managua. These interviewees acted as informants (describing the bigger picture and observations from a position as a scientific expert or a policy formulator). Participating organizations were first identified based on a preliminary literature review. The interviews with representatives from organizations then provided input on whom else to interview. Interview topics covered included how agroecology developed in Nicaragua, the organization’s goals concerning agroecology, its role in supporting agroecology, whom it



networks or partners with, what kind of projects it undertakes, and what challenges it has faced in supporting agroecology.

To gain a detailed understanding of what smallholder agroecological farms may look like in different agroecological zones (Evans and Jones 2011), interpretive farm walks were held with farmers around Jinotega, Waslala, and Estelí. Participatory workshops were held in the region around Estelí because it best represented smallholder farming systems around the country (e.g. farmers with cropping systems based on basic grains and livestock production for national consumption and not on (export) cash crops such as cocoa or coffee). Two kinds of workshops were held: one with farmers and one with representatives of local CSOs and farmer organizations. Participants of both workshops were identified through their membership in one of five local organizations who were members of the TLA. To strengthen the validity of the data gathered in the workshops, we aimed to capture the opinions of male and female farmers from a broad range of ages. Farmers acted as respondents, detailing their direct experiences with agroecology. The organizations facilitated initial contact with lead farmers in villages around Estelí. The lead farmers suggested other male, female, and youth farmers who might be interested in participating in the workshops, whom we contacted and invited to participate. The organizations also put out a broad invitation to all members to join the workshops. During the workshops with farmers, participants reflected on what ‘agroecology’ and ‘being an agroecological farmer’ meant to them, drew rich pictures of how their farms currently look and how they would look if they corresponded fully to the farmer’s ideal of an agroecological farm, and discussed challenges that prevented them from realizing their ideals of a fully agroecological farm. During the workshops with representatives of local organizations, participants presented their organization’s definition of agroecology, its goals in supporting agroecology, with whom and how it works to support agroecology, reflected on the challenges it faces in achieving its goals, and identified what steps it would need to undertake in the near and medium future to achieve these goals. Further, they discussed what kind of an environment they would need – outside of their organization – to be able to work more effectively in supporting farmers to produce agroecologically. To deepen ideas touched upon during the workshops, semi-structured interviews were held with several farmers and organizations. With the interviewee’s permission, the interviews were recorded. They were later transcribed by a Nicaraguan assistant. To identify themes emerging from the data, the transcriptions were coded in an ongoing process based on the grounded theory principles of objectivity and reflexivity (Strauss and Corbin 1990; Timonen, Foley, and Conlon 2018). Because research participants acted both as respondents (detailing their personal experiences) and informants (describing the bigger picture), thick data to be gathered on

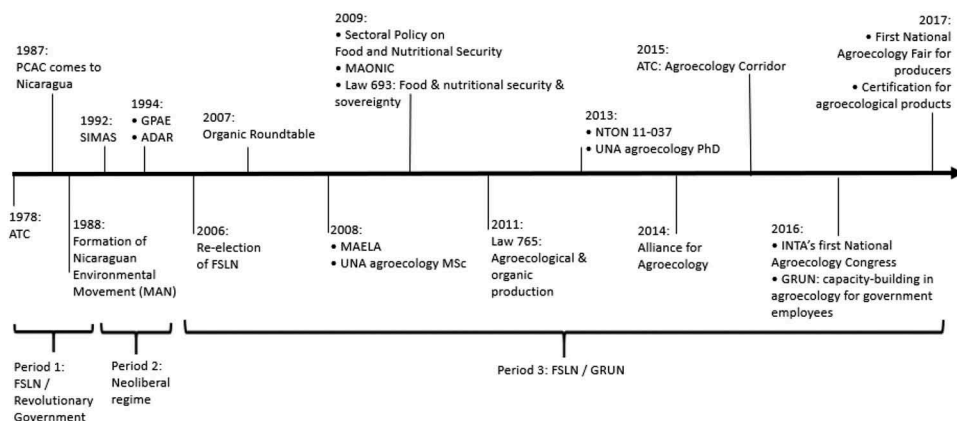
not only organizational issues, but also on personal experiences from those supporting the agroecological transition in Nicaragua.

We used an event history analysis to explore AeIS development over time, mapping the interactions between structural elements and system functions to analyze the main events in the development of the AeIS (Bergek et al. 2008; Hekkert and Negro 2009; Hekkert et al. 2007; Kebebe et al. 2015). The event history analysis focused on the development of the AeIS since 2007 since that is when the agroecological sector in Nicaragua can be said to have entered a phase of expansion. The event history timeline was first constructed based on the literature and document review and then validated and enriched with data gathered from interviews and workshops. The data from interviews and workshops was further analyzed to unravel the enactment and performance of the seven functions of TIS. Due to the dynamic characteristics of the AeIS' development, the results present an interpretative punctual approximation of the development of agroecology in Nicaragua.

## Results

### *Development of the agroecological innovation system*

The growth of the AeIS in Nicaragua can be divided into three phases, with developments in each phase strongly influenced by the ideology of the party in power (see Figure 2). The roots of agroecology lie in the Nicaraguan Revolution, which culminated in 1979 with the triumph of the popular revolution led by the Sandinista National Liberation Front (FSLN). Agroecology was introduced in Nicaragua in 1987, when the National Union of Farmers and Ranchers (UNAG) invited the Mexican Campesino a Campesino (farmer-to-farmer) movement to Nicaragua as part of a soil and water conservation program. There has been



**Figure 2.** Timeline of the three periods of the agroecological innovation system in Nicaragua, with main events of each period.

a marked increase in agroecological activity since the re-election of the FSLN in 2006. During the neoliberal regime of the 1990s, as state involvement was rolled back, non-governmental organizations (NGOs) proliferated. Agroecology continued to be spread by CSOs, NGOs, and local farmer organizations, but little happened at the level of government. Hence, we identify three periods in the development of the AeIS: the FSLN's Revolutionary rule from 1979–1990; the neoliberal regime from 1990–2006; and the current Government of Reconciliation and National Unity (GRUN), headed by the FSLN since 2006. [Figure 2](#) shows a timeline of these three phases. The subsequent analysis focuses on the period since 2006, when agroecology entered a phase of broader diffusion.

### ***Recent developments: The AeIS since 2006***

Since 2006, the agroecological transition has caught new headwind; the GRUN took a lead role in enacting national policies favorable to agroecology, and numbers of agroecology-minded platforms and networks increased. The GRUN re-oriented government policy to position the FSLN's Revolutionary ideal of self-sufficiency as central to equitable and rapid development (Godek 2015). Hence, the 2009 Sectoral Policy on Food and Nutritional Security and Sovereignty, part of the government's National Plan for Human Development, explicitly links national food security to agroecology in multiple government arenas like environmental conservation and public health (Herrera 2014). The national discourse on agroecology has widened to include e.g. broader environmental and ecosystem conservation goals, gender equality for women, youth, and other disadvantaged groups; CSOs have taken an active role in shaping national policy (Boone and Taylor 2016; Fréguin-Gresh 2017; Godek 2013). In 2011, the GRUN passed Law 765, the Agroecological and Organic Production Law. Formal interactions between organizations at the national level has taken off since 2007, with organizations promoting (agro)ecological farming practices joining together in umbrella organizations and networks.

### ***Structural – functional analysis of systemic problems in the development of the aeis***

Focused on the broader diffusion of agroecology since 2006, this sub-section analyzes the seven functions of the AeIS presented in [Table 2](#) above. First, factors that impede the functioning of the AeIS are identified; next, systemic problems hindering its growth are highlighted. These factors are summarized in [Table 5](#).

#### ***F1: Experimentation by entrepreneurs***

Representatives of local NGOs and producer organizations who have a broad overview of the types of actors in agroecology defined two different kinds of

**Table 5.** Summary of main positive and negative aspects of each function.

Function	Positive aspects	Negative aspects
F1: Experimentation by entrepreneurs	<ul style="list-style-type: none"> <li>- 3 decades of farmer experimentation</li> <li>- Experimentation and demonstration plots across the country</li> </ul>	<ul style="list-style-type: none"> <li>- Infrastructural difficulties</li> <li>- Insufficient market development by market actors</li> </ul>
F2: Knowledge development	<ul style="list-style-type: none"> <li>- Formalization of knowledge development through farmer organizations and public higher education system</li> </ul>	<ul style="list-style-type: none"> <li>- Dependency on donor funding</li> <li>- Government functionaries lack knowledge of agroecology</li> <li>- Insufficient human and organizational adaptive capacity</li> </ul>
F3: Knowledge exchange	<ul style="list-style-type: none"> <li>- Farmer to farmer schools and networks</li> <li>- Bachelor, Masters, PhD programs in universities</li> <li>- National networks and roundtables of organizations supporting agroecology</li> <li>- Regional and international knowledge exchange through NGOs and research organizations</li> <li>- Focus on youth outreach</li> <li>- Nascent: training for government employees and awareness-building of consumers</li> </ul>	<ul style="list-style-type: none"> <li>- Dependency on donor funding</li> <li>- "Islands of agroecology" that do not connect to other agroecological projects or organizations</li> <li>- Difficulties of working with municipal governments</li> </ul>
F4: Guidance of the search	<ul style="list-style-type: none"> <li>- Government has written agroecology and related issues into law</li> </ul>	<ul style="list-style-type: none"> <li>- Government does not focus on implementing its policies</li> <li>- Government's two-prong approach (on conventional agribusiness and on agroecology) is confusing for stakeholders</li> <li>- Difficulties of defining "agroecology"</li> </ul>
F5: Market formation	<ul style="list-style-type: none"> <li>- Creation of farmer's markets in municipalities and in the capital</li> </ul>	<ul style="list-style-type: none"> <li>- Low consumer purchasing power</li> <li>- Insufficient production of and access to agroecological inputs</li> </ul>
F6: Resource mobilization	<ul style="list-style-type: none"> <li>- International financial resource donors</li> </ul>	<ul style="list-style-type: none"> <li>- Lacking financial, human, and physical resource mobilization</li> <li>- Rapid change of government staff makes working with municipal governments difficult</li> </ul>
F7: Creation of legitimacy	<ul style="list-style-type: none"> <li>- Groundswell: 3 decades of farmer-to-farmer movement</li> <li>- Organizations linking farmer organizations and policy-making</li> </ul>	<ul style="list-style-type: none"> <li>- Difficulties of defining "agroecology"</li> <li>- Mixed messages of government</li> <li>- Insufficient creation of market opportunities and infrastructures</li> </ul>

agroecological entrepreneurs: those related to production (farmers) and those related to distribution (market-related entrepreneurs). Several CSOs, NGOs, and farmer organizations have supported farmer experimentation for the last few decades, and experimentation and demonstration plots have been established across the country. However, participants indicated several issues stifling farmers' experimentation. In workshops, farmers<sup>4</sup> explained that many farmers they know do not perceive agroecological production as a profitable economic activity. This is related to the lack of marketing opportunities and the perceived lack of agroecological products' added value. Rather, agroecology is seen as connected to topics of food security and the scarcity of farm inputs (interviews; Fundación Luciérnaga and

SIMAS 2010). Further, even among some farmers and extensionists who use agroecological practices, the adoption of agroecological systems thinking – i.e. managing the farm as one interrelated system – is more difficult (interviews; Bacon et al. 2014). Related to this, farmers mentioned that the focus of some cooperatives on the propagation of one crop stifles experimentation: Farmers are supported in producing one crop, which the cooperative then markets collectively, but not in diversifying their cropping systems (which is widely considered to be a basic tenet of agroecology, see e.g. Wezel et al. (2014). When representatives of cooperatives were asked about this, they explained that the one-crop focus is a practicality issue related to inadequate infrastructure – including good roads – for connecting rural villages to local markets.

Interviewees from NGOs and research organizations in Managua characterized experimentation with national markets and value chain creation by agroecological entrepreneurs as weak but improving (see also sub-section market development below). This experimentation has been led and reinforced by mainly local producer organizations, CSOs, and NGOs, acting with the permission of GRUN institutions, like the Ministry of Family, Community, and Cooperative Agriculture (MEFFCA) or the National System of Production, Consumption and Commercialization (SNPCC). Together with municipal governments, these institutions have worked on establishing alternative food networks in municipalities nationwide, including farmers markets and direct producer-to-consumer networks. A brand for agroecological products has been developed by the Group for the Promotion of Ecological Agriculture (GPAE),<sup>5</sup> with products found in markets and stores in the larger cities and municipalities. However, these marketing opportunities remain isolated and without a “big picture” for national agroecological market development.

Alternative possibilities for farmers’ experimentation were given by one interviewee, from an organization focused on finding opportunities for the development of alternative value chain and marketing arrangements between rural production and urban consumption zones. One suggestion was the development of ecotourism on agroecological farms. Such agri-ecotourism opportunities are currently found mainly in the coffee zone (around Matagalpa) and on permaculture farms on Ometepe Island.

## ***F2: Knowledge development***

In workshops, farmers<sup>6</sup> identified knowledge development as a function strongly filled by the AeIS. As mentioned above, three decades of agroecological knowledge-building and sharing by and between farmers has been a key point in creating a groundswell of knowledge of and support for agroecology. Farmer field schools and experimentation plots exist across the country. Workshop participants and interviewees from organizations in Estelí found these to be central in furthering specific local knowledge

development of farmers about agroecological production. They also serve in peer-to-peer knowledge exchange by farmers (see section on knowledge exchange below). Agroecological knowledge development has been formalized in national higher education curricula: The National Autonomous University in León (UNAN-León) has the oldest agroecological university program in the country, and the National Agrarian University (UNA) in Managua offers multiple degrees from technical to masters' level and a doctoral program in agroecology. Particularly in formally institutionalized agroecological knowledge development through higher education institutes, Nicaragua has the potential to be a regional "lighthouse" (Salazar-Centeno 2013).

Since 2007, the government's National Agricultural Technology Institute (INTA) has been given the lead role in linking research and policy (Fréguin-Gresh 2017). For example, INTA institutionalized a system of community seed banks (CSBs), spearheaded by PCAC-UNAG since 2002; by 2015, 380 CSBs<sup>7</sup> existed nationally (McCune 2016). In 2016 and 2017, INTA organized the First and Second International Congress on Agroecology in Managua – represented parties were national and international researchers, farmers, CSOs, government initiatives, and small companies offering agroecological inputs and products.

However, literature and policy documents show, and interviewees from NGOs and national universities confirmed, that much of the agroecological research and development sphere remains very dependent on international donor funding (Fréguin-Gresh 2017). For example, an interviewee described a study financed by an Austrian development organization that discovered a producer who controlled rat populations using a native tree that naturally repels rats. This old cultural knowledge had been hitherto unknown to scientists and came to the forefront through this donor-funded study. Two interviewees decried that in some instances donors have taken control of the organization or project – e.g. SwissAid of the national "Alliance for Seed Identity" (ASI), a network of organizations fighting for national seed sovereignty.

Most authors agree that agroecology is highly knowledge-intensive (Altieri and Toledo 2011; Bellamy and Ioris 2017; Caron, Biénabe, and Hainzelin 2014; Holt-Giménez and Altieri 2013; Isgren and Ness 2017; Miles, DeLonge, and Carlisle 2017). This indicates that not just farmers and technicians need practical knowledge, they also need social and economic knowledge, as one interviewee pointed out. Further, to be able to fully realize an agroecological transition, institutions and government functionaries need new organizational and technical knowledge, and the adaptive capacity to internalize and apply it. Agroecological knowledge development in Nicaragua has been hindered by a lack of human and organizational adaptive capacity: on the World Bank's statistical capacity index (which approximates a country's ability to collect, analyze, and disseminate high-quality data about its

economy and population), Nicaragua's score has recently decreased to 70 after a 2005 high at 83 (The World Bank 2017). An important step to grow government functionaries' knowledge has been made by UNA, whose agroecology degree programs have been frequented by employees of INTA.

### ***F3: Knowledge exchange***

Interviews and literature showed that the formal knowledge exchange infrastructures include farmer-to-farmer schools and networks and the national research institutes and international networks mentioned above. The technical and bachelor-level curricula of the national public higher education system includes agroecological knowledge via environmental knowledge and social justice classes (MAGFOR 2013; interviews). The Rural Workers' Association (ATC) has established several agroecology schools around the country based on the model of international peasant organization La Via Campesina's schools and the Freirian model of public education (McCune et al. 2016). Interviews with NGOs and research organizations and organizational documents showed that in recent years, organizations as varied as the PCAC-UNAG, ATC, and MAONIC, the coffee cooperative PRODECOOP, and NGOs such as the Tropical Agricultural Research and Higher Education Center (CATIE) and the Mesoamerican Information Service on Sustainable Agriculture (SIMAS) have focused on the systematization of existing knowledge and experiences of farmers, which is crucial to facilitate the exchange of information about successful adoption experiences in communities nationwide (MAONIC 2011; SIMAS and PCAC-UNAG 2015; Villanueva, Sepúlveda, and Ibrahim 2011). Interviewees, particularly of the organizations in Estelí, identified another focus of many organizations working in rural areas: institutionalizing youth outreach and training.

International farmer-to-farmer ties are fostered through producer organizations, NGOs, and CSOs: for example, a 2018 meeting on "Agroecology in Mesoamerica," organized by the intraregional Agroecological Movement of Latin America and the Caribbean (MAELA), GPAE, and ASI, brought together 40 Nicaraguan farmers and 25 producers from several central American and Caribbean countries.<sup>8</sup> Short courses on agroecology, bringing together students and practitioners from the United States and Latin America, have been organized by, for example, the USA-based Community Agroecology Network (CAN) in coordination with ASDENIC in Estelí. Intraregional institutes, like the Interamerican Institute for Agricultural Cooperation (IICA) and the Latin American Scientific Society for the Study of Agroecology (SOCLA), and national institutes like the Mesoamerican Agricultural Information Service (SIMAS) disseminate agroecological knowledge gathered across Latin America (Fundación Luciérnaga and SIMAS 2010; IICA, MAGFOR, and Austriaca 2009; SIMAS 2011b, 2011a).

Looking at organizational networks, in 2007 the now-defunct Organic Roundtable (Mesa Orgánica) for the first time brought together government entities, CSOs, producer groups, and private-sector actors. Interviewees stressed the important role played by the Mesa Orgánica in creating Law 765. In 2009 organic and agroecological producer organizations formed the National Movement of Agroecology and Organic Producers (MAONIC), a national round table with the explicit goal of anchoring organic and agroecological production in Nicaragua's legal framework.<sup>9</sup> Multiple interviewees highlighted MAONIC as currently playing the leadership role in Nicaragua's agroecological movement. The GPAE currently links 36 organizations – farmer cooperatives, CSOs, local farmer-to-farmer groups affiliated with UNAG (PCAC-UNAG) groups, and research institutions. Its programmatic goals include putting pressure on the GRUN to fulfill its commitments to agroecological development as specified in Law 765 (GPAE 2013). Looking at international knowledge exchange, civil society and research organizations have come together in the Alliance for Agroecology,<sup>10</sup> a network of institutions in seven Latin American countries that investigates not just agroecological practices, methodologies, and benefits, but also the processes through which CSOs and governments have formulated public policy promoting agroecology.<sup>11</sup> SOCLA has in recent years opened a chapter in Nicaragua, based at the UNA in Managua, and was instrumental in supporting the UNA in conceiving and implementing its PhD program in agroecology. MAELA, formed in 2009, ties together organizations from agroecological movements across the continent. Interestingly, interviewees confirm that ties to international peasant organization La Via Campesina (LVC), a major player in agroecology in countries around the world, are almost completely lacking. Currently, the ATC is the one of the few Nicaraguan organizations that remains a member of LVC,<sup>12</sup> but not even the PCAC-UNAG is still a member.

Realizing that government functionaries lacked information on agroecological farming, in 2016 the GRUN (led by INTA) implemented technical capacity-building in agroecological principles and practices for 72 functionaries in the SNPCC.<sup>13</sup> Other government functionaries have attended UNA's agroecology programs. Knowledge exchange has traditionally been weak on the demand side – Nicaraguan consumers are largely not aware of the benefits, be they social, ecological, or health-based, of consuming nationally and sustainably-produced food (interviews and Fundación Luciérnaga and SIMAS 2010). Organizations such as GPAE and several local CSOs are now working to increasing consumers' awareness of these benefits (particularly in the larger cities and municipalities around the country) through advertising and public awareness campaigns on TV and in national print media (Gutiérrez 2017).



Finally, although it appears that several networks supporting the agroecological transition exist in Nicaragua, multiple interviewees commented on the “islands of agroecology” within Nicaragua’s AeIS. They explained that although many groups support agroecology, their work is undertaken without a bigger picture approach and in isolation, without an overarching vision or alignment with other stakeholders’ foci; hence, they fail to capitalize on existing synergies. Another example of this given by interviewees in this study is the ATC, which, as several interviewees from organizations working at the national level explained, works independently from other national organizations. A further example, expressed by interviewees from organizations in Estelí, is difficulties in working with municipal governments because they are mostly funded by, and answer directly to, the national government, municipal governments must get approval from the national level before participating in local projects. This process is usually arduous and time-consuming, and often results in non-approval from the national government. Hence, municipal governments’ action radii are limited; this means most rural projects function independently although they may be located in the same zone.

#### ***F4: Guidance of the search***

Literature and policy documents show that Nicaragua’s government has been the principal provider of credit, technical assistance, and social services to the agricultural sector since the 1980s (Araújo and Godek 2014; Fréguin-Gresh 2017; Saravia-Matus and Saravia-Matus 2009). In recent years, the GRUN has instituted a two-pronged plan for agricultural development: supporting big agribusiness growth, on one hand, and smallholder production on the other (Ripoll 2018).

In 2011, the GRUN passed Law 765, the Agroecology and Organic Production Law (GRUN 2011), followed in 2013 by the associated Technical Norms for Agroecological Production (NTON 11–037), which provide standards for agroecological production units (GRUN 2012). Law 765 is part of a host of legislation concerning broader social and environmental justice issues that has been passed by the GRUN since 2007 (see Table 6) (MAGFOR 2013).

**Table 6.** Legislation on agroecology and related topics since 2007.

Year	Law (number, issue)
2007	620: Regulation of national water sources
2008	648: Equal rights and opportunities for all citizens
2009	693: Food and nutrition security and sovereignty
2010	705: Regulating the use of biotechnology
2011	747: Animal rights
2011	765: Agroecological and organic production
2012	807: Conservation of biodiversity

Like other laws on related issues like food sovereignty, it was formulated through a process of stakeholder consultation (Godek 2015). Yet, it became clear during the consultations that different organizations were promoting different definitions of (agro)ecological agriculture (Alianza por la Agroecología 2014; Fréguin-Gresh 2017). Further, interviewees from NGOs and producer organizations in the capital maintained that outside influence in the formulation of Law 765 – specifically, the FAO’s involvement (as requested by a government functionary) – watered down the law by, for example, deleting the term “food sovereignty” and leaving in “food security.” As interviewees stated, the competing discourses – of organic and agroecological production – can be seen in the wording of the law (this is also highlighted by Alianza por la Agroecología (2014)). Interviewees from agroecological organizations, in particular, feel that the law focuses more on the model of organic farming: it combines agroecological and organic production into one piece of legislation, and the NTON 11–037 are unrealistically precise (mirrored in statements in (Alianza por la Agroecología 2014)).

In interviews, stakeholders, including farmers, technicians, and researchers, perceived the Nicaraguan government as providing inconsistent guidelines for agricultural development. Actors see this as an effect of the government’s business-as-usual attitude towards conventional agricultural production, including the continued subvention of chemical inputs and persistent favoritism in government policies towards large landowners with intensive mono-cropping, animal production, or highly agri-chemical input dependent crops such as tobacco (Alianza por la Agroecología 2014). Issues mentioned in the workshops that affect would-be agroecological farmers included the insecurity of land tenure and plot fragmentation; the inherent insecurity of being a small, nature-dependent producer; and the secure income offered if farmers lease their land and labor to tobacco farms. Farmers feel that these issues are not addressed by the national government. Further, interviewees indicated that crucial issues stipulated in Law 765, including specific financial instruments for agroecological farmers and the creation of a national council to support agroecology,<sup>14</sup> have not been implemented (reflected also in (Alianza por la Agroecología 2014)). Working with municipal governments was highlighted as difficult by interviewees, as the former do not have a specific office for agroecology and contact must be made through one of the municipal commissions on related subjects such as food security or environmental protection (PCAC, UNAG, and IDS (2017) mention this too). Hence, as other authors have noted, regarding, for example, the implementation of food sovereignty in agri-food policy, “while the law provides a clear institutional structure, it lacks a ‘road map’ for the implementation process” (Araújo and Godek 2014, 69). Further compounding the confusion are the GRUN’s conflicting demands and policies. For example, the GRU calls for rapid crop yield increases and

simultaneously for agro-ecosystem restoration, a medium- to- long-term process. The GRUN's policies support agroecology but also continue to regard the export-oriented production of high-value crops as a pillar of national economic development (Fréguin-Gresh 2017). This latter focus includes, for example, continued state subventions for fertilizers such as urea (Baca Castellón 2018). Since 2013, the government has been flirting with a “middle path” of agroecology that allows the use of certain agrichemicals (defined as “green” in the government’s “stoplight” – i.e. green/yellow/red list of harmful agrichemicals) in agroecological farming (Baca Castellón 2015), even though this is forbidden by Law 765.

Mixed messages stem from not just the government itself, but also from closely affiliated organizations such as UNAG, the nation’s largest association of small- and medium-sized producers. Although it was instrumental in introducing agroecology in Nicaragua, UNAG has swung back and forth on including agroecology in its programs.<sup>15</sup> Because it re-involved itself in agroecology so late, interviewees from other organizations fear that UNAG’s associates lack appropriate knowledge of current agroecological practices and paradigms. From farmers’ perspectives, organizations promoting both conventional agriculture and agroecology are very confusing. A specific example given was farm visits from both conventional and agroecological extension agents from the Association for Development of Nicaragua (ASDENIC), which operates in northern Nicaragua. Farmers and CSO representatives lamented that this inhibits farmers’ experimentation with agroecological practices and undermines agroecology’s legitimacy.

### ***F5: Market formation***

Dividing market formation into input- and output-related markets highlights disparities in market development. Input markets for agroecological inputs (e.g. clean native seeds, bio-fertilizers, and organic pest and disease management products) have been slow to develop, with farmers in workshops and interviewees from universities and NGOs highlighting sufficient seed production as particularly problematic. In workshops, farmers described the lack of timely access to clean native seeds and pest and disease management products as a main hindrance to adopting agroecology. Other interviewees from local organizations in Estelí mentioned the lack of sufficient manure to fertilize fields as a large hindrance affecting particularly the most resource-poor farmers, who may not own the large livestock that produces manure.

Output markets have mushroomed in recent years. The GRUN, municipal governments, and CSOs have supported the opening of farmers’ markets in municipalities nationwide. Stores selling agroecological products have opened in municipalities and cities across the country. Several farmers’ markets in Managua and surrounding towns foment direct interaction between consumers and producers. Farmers selling here do not necessarily

have to be certified but must be using ecological practices, without agrochemical use, on their farms (La Prensa 2015). Urban consumers can participate in community-supported agriculture schemes,<sup>16</sup> or shop in grocery stores devoted to local and ecological products. Agroecological products are being marketed towards the tourist segment; producer groups market directly to stores and restaurants in tourist hot-spots such as Granada, San Juan del Sur, León, and Rivas (El Nuevo Diario 2017). GPAE has developed a collective brand<sup>17</sup> for agroecological products, focused on the national market. Other certifications exist through BioLatina, which works through collective certification,<sup>18</sup> mostly for organic products destined for export. Further market-related changes include the first national trade fair, organized in 2017 by INTA and MAONIC, for small and medium-sized agroecological and organic producers. This event brought together producers and organizations from around the country with consumers in Managua.

Yet, other problems persist. Visits to farmers' markets in the municipalities have shown that often, agroecological products sold there are not differentiated from conventional products; hence, there is no price premium. In Managua, some farmers sell agroecological produce in farmers' markets, but this is based on individual trust between producer and consumer. Further, these markets tend to be small in terms of consumers. Although urban demand is growing, the financial constraints of many urban consumers limit the size of this market; this issue is more pronounced in rural areas. To overcome these issues, interviewees noted that several organizations are working together to create four large central markets in Managua where producers can directly interact with urban consumers. Certifications, such as offered by BioLatina, may be prohibitively expensive for cooperatives. A (low-cost) public certification scheme for agroecological and organic products has been developed based on Law 765 and the NTON 11-037, but has not been implemented (Alianza por la Agroecología 2014). A different issue raised in interviews was skepticism concerning consumers' willingness to pay a price premium for agroecological produce, which was perceived as linked to consumers' lacking information on the benefits of purchasing and consuming locally and agroecologically produced food. Finally, three interviewees explained that insufficient production of large quantities of agroecological products is a bottleneck. These interviewees explained that national market opportunities involving the production of large quantities of agroecological produce, such as selling to the national supermarket chains, involve too many intermediaries and long value chains (from the producers' perspective) and too low, or unstable, volumes of production of too many products (from the supermarket perspective) (as also noted by Michelson, Reardon, and Perez (2012)). As one interviewee mentioned, several years ago the now-Vice President of Nicaragua, Rosarillo Murillo, attempted to launch a program to procure all foodstuffs for

government canteens from national agroecological farms. Yet, the relatively small quantities produced by agroecological farmers, and the lack of an organization to coordinate this nationwide, meant that this demand could not be satisfied by production levels.

### ***F6: Resource mobilization***

In the workshops and interviews, all participants perceived resource mobilization as lacking in financial, physical, or human aspects. Financial infrastructure is missing in two main areas: 1) support for farmers during the time of transition to agroecology and 2) in specific financial products for agroecological farmers. While transitioning to agroecology, yields are often low; farmers and technicians mentioned the time lag between investment and higher productivity as a large deterrent to farmers' adoption of agroecological practices. Interviews indicated that although agroecological farmers face different risks than conventional farmers, no specific financial instruments for agroecological production, like credit or insurance, are available from national banking institutes – not even from the Banco Produzcamos, the GRUN-mandated bank for small and medium-sized farmers, specifically mentioned in Law 765 as the go-to bank for agroecological producers (Alianza por la Agroecología 2014). Particularly the lack of a specific GRUN budget dedicated to the development and implementation of agroecology programs, including research on bottlenecks like insufficient production of and access to bio-inputs, has hampered further implementation of Law 765 (Baca Castellón 2018; Fréguin-Gresh 2017). This means that the mobilization of financial resources for agroecology has been strongly led by international donor organizations,<sup>19</sup> and not by the national government (Fréguin-Gresh 2017). Many (national) NGOs with international financing have projects on agroecological themes. One interviewee sees this as a result of the drawback of the state during the neoliberal regime of the 1990s, during which NGOs mushroomed into the spaces vacated by the public sector. A related concern, mentioned by interviewees from organizations that work with the government, is the issue of globalization, which has opened opportunities for transnational companies' investment in Nicaragua – but this investment usually does not consider social or environmental dimensions. Nicaragua has a friendly climate towards foreign direct investment. In 2017, PRONicaragua, the government agency in charge of foreign investment, was recognized by the World Bank as one of the world's top investment facilitators, a recognition given for the first time to an institution in a developing country (Ripoll 2018). According to interviews, an unexplored issue is the question of ecosystem services payments for agroecological farmers. Interviewees from NGOs and research organizations expressed that this could take two forms: a direct valorization of, and payment for, ecosystem services provided by ecological agriculture, similar to what exists in other

countries, or a more structural change, by integrating the costs of negative environmental impacts caused by conventional agriculture into a national cost-benefit scheme.

Concerning physical resources, technicians and farmers mentioned lacking sufficient and timely access to bio-inputs (clean native seeds, organic fertilizer, biological pest- and disease-control products) as a large hindrance to farmers (see sub-section on market formation above). In workshops, farmers talked about the fragmentation of their fields into disparate plots, making it more difficult to implement time- and labor-intensive agroecological practices, as economies of scale are not possible. Fragmentation of fields also makes more pertinent the problems caused by neighboring conventional farmers' fields' agrichemical runoff, which negatively impacts efforts to maintain agroecological fields as well as certification standards.

Farmers indicated that insufficient availability of manpower in rural areas hinders the spread of labor-intensive agroecological production. Many small farmers, particularly in the tobacco and sugarcane growing areas, find it more financially stable to rent out their land to these agro-industries and work as laborers therein. As is the case in many countries, many rural Nicaraguan youth see more opportunities in urban areas and overseas.<sup>20</sup> These factors lead to a lack of manpower for agricultural production in rural areas. Human capacity in government institutions was seen as severely lacking by interviewees. In particular, MEFFCA, which is responsible for agroecological market development, was perceived as lacking sufficient human resources to support all the projects they are supposed to be running. Municipal governments, which could be implementing agroecological projects, must work solely with government institutions and funds, and thus lose out on the knowledge and capacity of local producer organizations, NGOs, and CSOs. A separate issue mentioned in interviews was the rapid change of government officials, particularly at the municipal level, which was seen to impede the creation of stable relationships and hence, hinder the institutional anchoring of and government support for agroecological projects in the municipalities.

### ***F7: Creation of legitimacy***

The interplay between “top-down” (government policy and strategies) and “bottom-up” (through the farmer-to-farmer outreach of producer organizations and CSOs) actions for the agroecological transition has shaped the development of the AeIS since the 1980s by creating legitimacy for agroecology at both national policy and grassroots levels. Organizations that work on both aspects, such as MAONIC, have played an important role in presenting agroecology as a productive alternative – increasing environmental sustainability and food security of farming systems – to both local organizations and national policy-makers. Particularly MAONIC plays a central role in

strengthening agroecology's legitimacy, with interviewees from organizations in the capital and in Estelí mentioning the organization as holding a leadership role in furthering the agroecological transition in Nicaragua. Other actions that support the creation of legitimacy for agroecology include territorial-based initiatives, such as those pushed by the Association for Rural Agroecological Development (ADAR) since the 1990s, and which have been undertaken by multiple institutions.<sup>21</sup> Agroecology's growing legitimacy within the formal research and education communities can be seen in UNA's development of a doctoral program in agroecology and INTA's organization of the Agroecology Congresses in 2016 and 2017. These factors have increased agroecology's legitimacy nationwide, but interviewees identified (and documents bolstered) three issues that significantly lessen agroecology's legitimacy: 1) different definitions of ecological agriculture held by organizations, networks, and the GRUN<sup>22</sup>; 2) mixed messages concerning agroecology (discussed above in the sub-section on guidance of the search), evidenced perhaps most clearly in the legislation but non-implementation of Law 765; and 3) insufficient creation of market opportunities and financial infrastructures (see sub-section on market creation above). The lack of agroecology's legitimacy at a national level may perhaps be exemplified in the fact that agroecological farmers are not counted by Nicaragua's agricultural census, held every decade, and interviewees do not think that agroecology will be included in the next census either.

### ***Interdependence of systemic problems***

The functional-structural analysis in [Table 7](#) above presents systemic problems that deter the development of the agroecological innovation system. The results show how weaknesses of the structures, and ensuing interactions between them, form the blocking mechanisms hindering the further diffusion of agroecology. Three central conditions cause a chain of issues that negatively impact the further diffusion of agroecology, with the feedback between them causing vicious cycles of problems (Hekkert et al. 2007), 1) The lack of a shared common vision for development of the agroecological innovation system negatively impacts every other aspect of the system; 2) hard and soft institutional problems hamper experimentation by entrepreneurs and market formation; and 3) the lacking creation of legitimacy causes vicious cycles throughout the system. These blocking mechanisms are illustrated in the following sub-sections.

#### ***A lacking common vision for agroecology negatively impacts all other functions in the system***

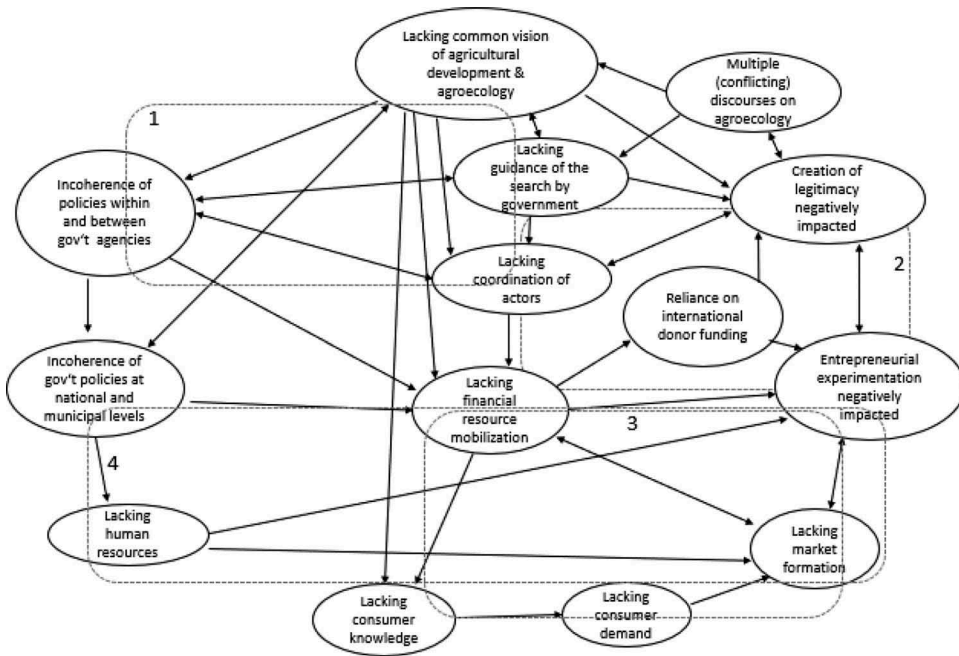
Lack of a common vision for agroecology resonates and creates problems throughout the system (see [Figure 3](#)) and is partially caused and affected by



**Table 7.** Systemic problems hampering the further growth of the agroecological innovation system in Nicaragua.

System function	Systemic problems hampering system functions	Description of links between systemic problems
F1: Experimentation by entrepreneurs	Missing actors Interaction failure Hard institutional failure	Different groups of actors are affected by different systemic problems. Experimentation by the private sector is weak esp. concerning market development, as they don't see opportunities for financial gain – this is related also to lacking information/demand on consumer side. Amongst farmers, experimentation is stifled by the 1-crop-focus of some cooperatives, as well as by opposing policies within and between government institutions. Further issues include land tenure insecurity, land fragmentation, and the lack of government (financial) support for farmers in transition period.
F2: Knowledge development	Missing actors, Hard institutional failure Lacking capacity of actors	This relates to weak human, organizational, and institutional adaptive capacity, connected to the lacking guidance of the search at national level. Related to this is weak consumer knowledge and market development – most ecological production focuses on export crops, and the national market is incipient.
F3: Knowledge exchange	Hard and soft institutional failures Infrastructure failure Interaction failure	Connected to the "islands of agroecology", weak organizational capacity, and weak guidance of the search, knowledge exchange between different stakeholder groups remains weak.
F4: Guidance of the search	Missing actors, hard institutional failure Interaction failure	Lacking coherence of government policies concerning agroecological and conventional agriculture lead to further mismatch between national policies and their implementation at municipal scales.
F5: Market formation	Lacking presence and quality of actors and infrastructures Hard and soft institutional failure Interaction failure	National input and output markets growing but insufficient, including the lack of consumer awareness of benefits of buying agroecological products, lacking differentiation of agroecological products in markets and connected to this, the lack of a price premium. Lacking knowledge of NTON 11–037 and certification possibilities, by farmers and technicians, further impedes market development.
F6: Resource mobilization	Lacking presence and quality of actors, interactions, institutions, infrastructures	Lacking resources include financial instruments for the parameters of agroecological production, lacking sufficient and timely access to bio-inputs, and low profit margins for producers.
F7: Creation of legitimacy	Lacking presence and quality of physical and financial infrastructures; hard and soft institutional failure	Countermanded through government's continued focus on conventional production, as well as by contradictory policies within and between government institutions, including lacking resource mobilization and market development.





**Figure 3.** The lack of a common vision for agroecology as a central blocking mechanism impacting all other system aspects (vicious cycles 1–4 identified by dotted lines; arrows indicate one-way or two-way relationships between issues).

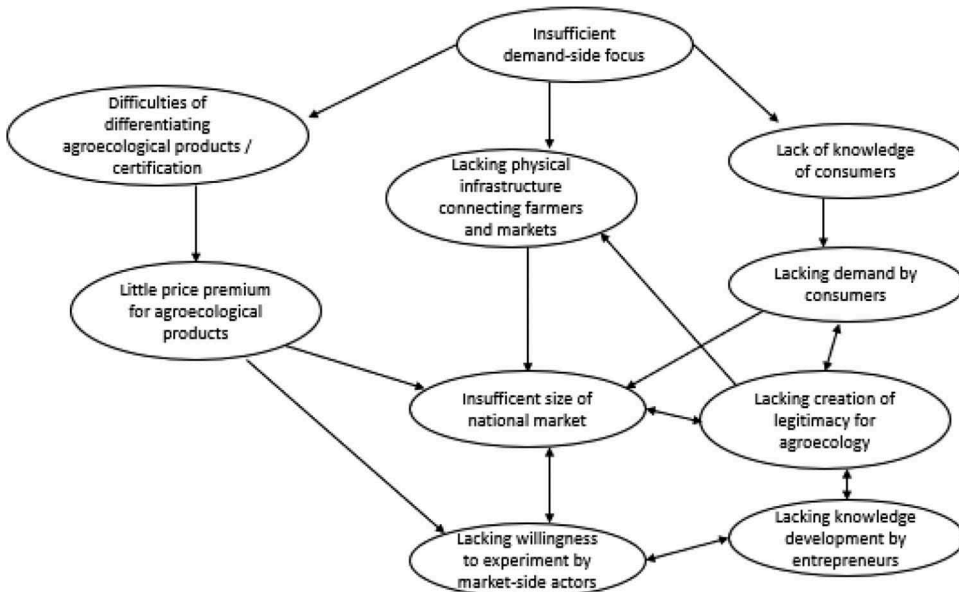
the lacking guidance of the search by the government. This in turn feeds into, and is fed by, incoherence in government policies. Policy mismatches may be found within institutions, between institutions, and between levels of government (i.e. national and municipal). All these issues mean that stakeholders, particularly those government-affiliated, are not coordinating their actions to the extent they might to leverage scarce resources. This, in turn, feeds into vicious cycle 2: the non-mobilization of government and national funds in turn implies that international donor funding remains an important source of financing for agroecological projects. Since donor funds tends to be localized in distinct projects, not contributing to an overarching plan of national agroecological development, the creation of legitimacy for agroecology is further negatively impacted. Further, without the security of national legitimization of agroecology, experimentation by both farmer-entrepreneurs and market entrepreneurs is weakened. The lack of financing for agroecology feeds into vicious cycle 3: the absence of market formation results in reciprocal negative effects concerning experimentation by entrepreneurs. The lack of financing also means that little consumer-side knowledge development is initiated, further weakening consumer demand and the creation of markets. This connects to vicious cycle 4: the incoherence of government policies, particularly between national and municipal legislation and implementation, negatively impacts not just financial, but also human resource

mobilization. This in turn limits market formation and entrepreneurial experimentation.

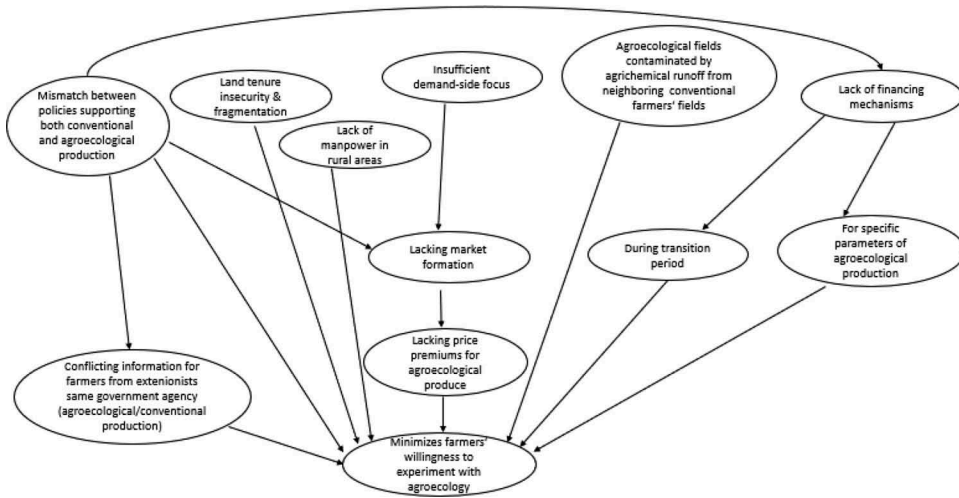
#### 4.4.2 Hard and soft institutional problems negatively impacting experimentation by entrepreneurs and market formation

Experimentation by both market entrepreneurs and farmer entrepreneurs is negatively impacted by hard and soft institutional problems that reverberate throughout the system (Figures 4 and 5, respectively). Government policies and strategies have emphasized agroecology, particularly as part of the national (food) sovereignty rhetoric, but their implementation has focused on the technical and knowledge aspects of production without linking to the necessary demand-side institutional innovations (Figure 4). Particularly weak are the creation of the relevant physical and financial infrastructures for (input and output) market development, links with private sector actors, and the fomenting of consumer demand. A vicious cycle can be seen in the links between weak market development, weak knowledge development by market entrepreneurs, their lack of experimentation, and insufficient creation of legitimacy for agroecology.

Farmers' experimentation has historically driven the diffusion of agroecology in Nicaragua. However, we find that hard and soft institutional problems negatively impact farmers' resources and their ability to experiment with agroecological practices on their farms (Figure 5). These hard institutional failures include land tenure insecurity, land fragmentation, and contamination of agroecological fields with agrichemicals from neighboring conventional fields; renting



**Figure 4.** Hard and soft institutional problems weakening market entrepreneurs' willingness to experiment (arrows indicate one-way or two-way relationships between issues).

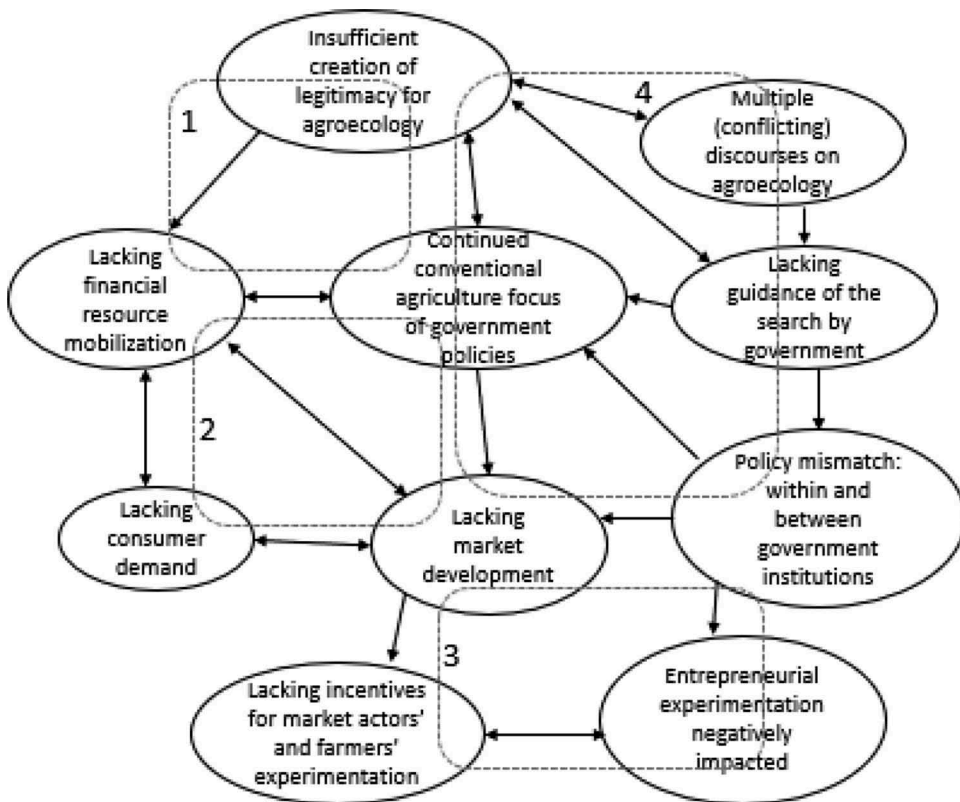


**Figure 5.** Hard and soft institutional problems negatively impact farmers' willingness to experiment with agroecology (arrows indicate relationships between issues).

out fields that were being ecologically managed to agro-enterprises that then use conventional methods to grow monocultures; lacking manpower; missing financing mechanisms appropriate to the specific parameters of agroecological production; and lacking infrastructure to get their products to markets, which leads to the necessity of using middlemen who may capture added value. Further, because the government lacks a clear idea of the further development of agroecology and continues to focus on conventional agriculture, the same institutions may provide extension for both conventional and agroecological agriculture, which may be very confusing to farmers.

### ***Lacking creation of legitimacy creates vicious cycles throughout the system***

Lacking creation of legitimacy seems to impact negatively on many of the other system functions, creating vicious cycles that reverberate throughout the agroecological innovation system (Figure 6). A central reason for the insufficient legitimization of agroecology are the multiple discourses on agroecology, which run parallel to each other and compete for dominance. On the one hand, the more production-oriented approach is reflected in what we can call the “organic discourse,” while the social and environmental justice aspects of agroecology are more broadly reflected in the “agroecological discourse.” The conflicting discourses are also found in different organizations that work with farmers, each using their specific definition of agroecology. Further, some organizations that do rural extension have different departments focused on conventional and on agroecological agriculture, with extension agents promoting one or the other – at times to the same farmers. These conflicting discourses feed directly into the contrary policies



**Figure 6.** Insufficient creation of legitimacy causes vicious cycles throughout the agroecological innovation system (cycles 1–4 identified by dotted lines; arrows indicate one-way or two-way relationships between issues).

and practices, supporting either conventional agriculture or agroecology, which are found within government agencies, between different government institutions, and between government institutions operating at national and municipal scales of government. Hence, we see that the institutional framework supporting agroecology is fragmented, with a semi-developed framework for theory and practice of each discourse.

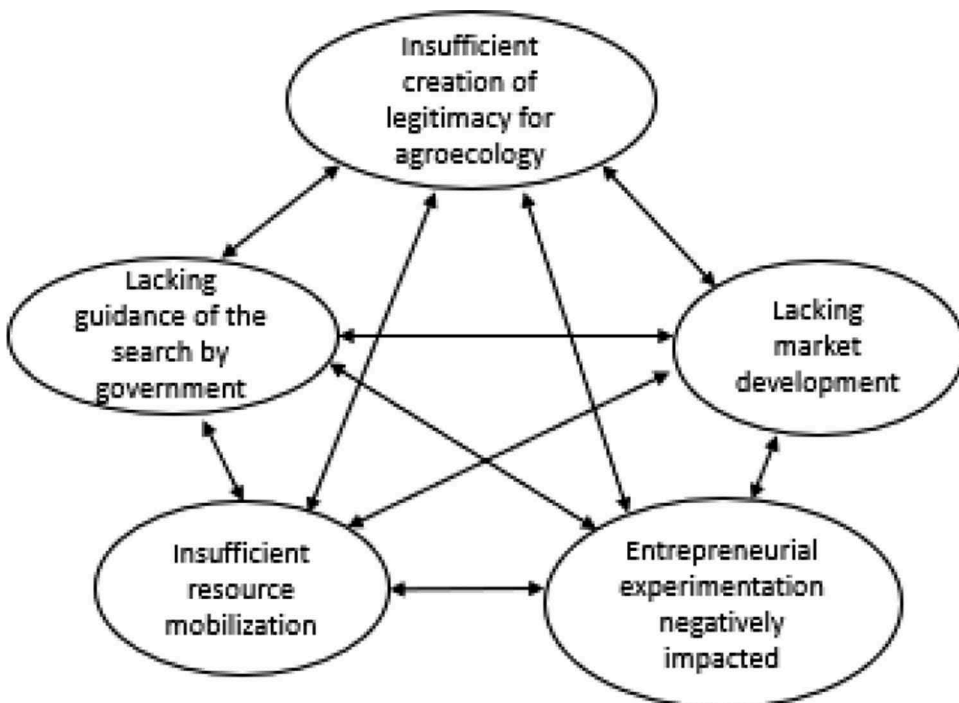
Four vicious cycles can be identified. In cycle 1, insufficient creation of legitimacy and the continued conventional agriculture focus of the government influence each other and lead to the weak mobilization of financial resources. This feeds into cycle 2, in which the lack of financial resources and the focus on conventional agriculture lead to insufficient market development and insufficient consumer demand creation, which also impact negatively on each other. Elements of vicious cycle 3 connect to issues in the other three cycles. The insufficient creation of legitimacy for agroecology is intimately interlinked with the multiple conflicting discourses on ecological agriculture, which both feed into and are influenced by the lacking guidance of the search by the government. Lacking guidance of the search is

exemplified by the government's continued focus on conventional agriculture and policy mismatches between and within government institutions and levels; these lead to a lack of incentives for entrepreneurial experimentation and activity, as demonstrated in vicious cycle 4.

## Discussion

### *The role of interconnected problems hindering the breakthrough of agroecology*

Using the TIS approach, we were able to categorize distinct problems in the functions and the structural components of the AeIS. This adds to earlier work in agroecological literature (e.g. Mier Y Terán Giménez Cacho et al. 2018) by identifying not just single issues, but interrelationships between problems that form vicious cycles blocking the development of the agroecological transition. Figure 7 illustrates the overarching functional problems hindering the further diffusion of agroecology. It demonstrates the interdependence of the different parts of the AeIS: a weakness in one can have a cascade of (negative or positive) effects in others, an issue mentioned, but not systematically explored, by other authors (e.g. Isgren 2016). Highlighting the centrality of co-innovation processes by stakeholders from different areas (Klerkx, van Mierlo, and Leeuwis



**Figure 7.** Vicious cycles between central functions that hinder the further diffusion of agroecology (arrows indicate interrelationships between issues).

2012), the TIS approach also enables a differentiated analysis of stakeholders' possibilities to further grow the AeIS.

Figure 7 illustrates that the TIS analysis allows us to identify specific vicious cycles that exist between the lacking creation of legitimacy, guidance of the search, market formation, experimentation by entrepreneurs, and resource mobilization. Interestingly, the functions knowledge development and exchange do not seem to be as affected. Reasons may include the relatively stable institutional setting of the knowledge development and exchange infrastructures, which are based in either the national universities, or in peer-to-peer exchanges by farmers (and technicians). This institutional stability may relate to sunk interests in resources such as knowledge infrastructures (e.g. institutionalized teaching programs from technician to doctorate levels) or physical resources (e.g. land used for experimental farms, farmer field schools, and demonstration plots). Further, capacity-building is writ large on the agendas of international organizations, which as our research shows, figure prominently in the funding of agroecological projects in Nicaragua.

Authors writing on agroecological transitions have reflected on the difference between “soft” (focusing only on technological aspects) and “hard” (encompassing broader system change, such as changed political and social contexts) agroecological transitions (Angeon and Chave 2014). In Nicaragua, this divide is mirrored in the competing discourses on “ – the more productionist, technologically-focused notion of organic agriculture, and a more comprehensive vision of agroecology, including social justice issues.” The struggle between these two discourses strongly negatively impacts the further diffusion of agroecology for several reasons. First, without a clear definition of agroecology, government institutions use one or the other discourse, feeding into conflicting policies within and between state institutions. Second, research institutes, universities, NGOs, and CSOs working in Nicaragua use “their” definition, which hinders their ability to work together and jointly leverage resources. Difficulties that may arise from diverging definitions of agroecology have been highlighted by other authors<sup>23</sup> (Bellamy and Ioris 2017; Giraldo and Rosset 2017; Rivera-Ferre 2018; Somarriba et al. 2012).

Lacking state leadership in promoting agroecology has been regarded as a key hindrance to its development, but in Nicaragua, policy is in place. With its enshrinement in national law, agroecology in Nicaragua changed from being a social movement to being formally institutionalized in national policy. This is in line with general trends of agroecology moving into the political sphere (Bellamy and Ioris 2017; Gonzalez de Molina 2013; Gonzalez, Thomas, and Chang 2018; Levidow, Pimbert, and Vanloqueren 2014; Meek 2016; Sabourin et al. 2017). The policy has enhanced agroecology's legitimacy vis-à-vis conventional agriculture and

has boosted institutionalization in knowledge and research institutes and infrastructures. However, our analysis highlights that policy alone is not sufficient to create legitimacy for agroecology. Our study shows disparities between policy and its implementation, a gap which has been identified in literature as blocking general innovation system growth, especially in emerging economies (Intarakumnerd and Chaminade 2007). An understudied aspect of agroecological knowledge development is what forms of knowledge are needed by government functionaries to better support the agroecological transition. The trend of agricultural research and development in emerging economies being dependent on foreign donor funding has been noted by other authors (IFPRI and IICA 2008), as have the mixed impacts of foreign or transnational institutions financing of elements of sustainability transitions in emerging economies (Hansen and Nygaard 2013; Sixt, Klerkx, and Griffin 2017). Beyond international financing mechanisms, transnational information linkages have also been shown to be important influencers for sustainability transitions in emerging economies (Binz, Truffer, and Coenen 2014). Both trends can be seen in Nicaragua. Historically, Nicaragua was important to the consolidation of LVC as a movement and its framing of food sovereignty (Edelman 2008; Godek 2015; Mier Y Terán Giménez Cacho et al. 2018); currently, multiple networks link national organizations with regional and global agroecological institutions. Hence, Nicaraguan agroecology is part of the process of “glocalization,” in which local practices are informed by (and in turn form part of and inform) an emerging global TIS, a “community that shares cognitive, formal and normative rules” (Schot and Geels 2008, 543). As can be seen by the example of FAO’s influence in shaping Law 765, glocalization remains an interesting avenue for future research. Our TIS analysis supports Blesh and Wolf’s finding find that agroecological transitions are “socioecologically mediated,” i.e. constrained and enabled by biophysical and socioeconomic resources, and multilevel, involving individual as well as collective action (Blesh and Wolf 2014, 433). Further, we agree with Mier y Terán Giménez Cacho et al.’s conclusions regarding the eight drivers of agroecological transitions, which can also be seen as socioecologically mediated (Mier Y Terán Giménez Cacho et al. 2018). As our study demonstrates, a focus on social and environmental benefits, but a lack of attention to the market side, may be detrimental to cementing agroecology’s legitimacy, as has been shown for the related subject of food sovereignty (Thiemann 2015). Authors have shown that local market development, favorable to producers, is necessary to further grow the AeIS (Khadse et al. 2017; Mier Y Terán Giménez Cacho et al. 2018). The TIS analysis allowed us to tease apart individual issues. By highlighting their inextricable linkages, it enabled us to untangle some of

the thornier issues and supported other authors' arguments for the necessity of coupled innovations between agricultural technologies, institutions, and organizational structures (Gaitán-Cremaschi et al. 2019; Khadse et al. 2017; Meynard et al. 2017).

### ***Contributions to promoting agroecology in Nicaragua***

In Nicaragua, bottom-up (lead by grassroots organizations) and top-down (lead by national government) processes are in play, an element which other authors have identified as critical to the diffusion of agroecology (Tittonell et al.; Toledo 2012). Our research has highlighted several other issues that could be improved upon to further the transition. For all of these issues, the creation of a “thick legitimacy” for agroecology – as suggested by (Montenegro de Wit and Iles 2016) and including scientific, political, civic, legal, practical, and economic evidence in favor of agroecology – could aid in supporting the agroecological transition.

We agree with Ramos-Mejía, Maria Franco-Garcia, and Jauregui-Becker (2018) that, in emerging economies, “the role of socio-technological innovation is not only about becoming more resource-efficient, but about reconfiguring power balance within production-consumption systems” (Ramos-Mejía, Franco-Garcia, and Jauregui-Becker 2018, 222). Yet, as also mentioned by Fraser, Fisher, and Arce (2014), this is not (yet) occurring in Nicaragua: conventional agriculture remains entrenched as the main form of production and the question of power imbalances is not addressed (De Laiglesia 2011). This stems partly from lacking policy coordination within and between government agencies, at both national and municipal levels: this negatively impacts all other functions, particularly the creation of legitimacy for agroecology as a viable option for farmers. Yet, the lack of a common vision of agroecology, illustrated by the competing discourses on agroecology, can be identified as a root of the policy mismatches. Without the development of a solid institutional framework for agroecology, based on a common definition of the term, the further development of agroecology may be difficult. The stronger implementation of the agroecological councils that are written into Law 765 could bring together stakeholders to formulate a joint vision of agroecology and agroecological development in the country. Following Amekawa et al. (2010), the innovative inclusion of non-traditional actors, such as NGOs, CSOs, or private sector actors, in these councils and in agroecological networks could support the development of national market opportunities. The formation of human resources in government organizations – for functionaries implementing agroecology policy, and for researchers and functionaries in the government's Agricultural Research and Innovation System, could aid in bettering policy implementation and research processes (Muñoz Izaguirre 2017).



The problematic of “islands of success” of isolated agroecological projects has been noted by other authors (Gonzalez de Molina 2013). The development of “agroecological territories,” which is already being pushed by multiple research organizations, NGOs, and CSOs, is an important next step in consolidating the “islands of agroecology” working in a specific region (Landero et al. 2016) and enhancing food self-sufficiency (Schipanski et al. 2016). However, in addition to this bottom-up work, processes of territorial consolidation also need supportive public policy, the involvement of local governments, and political will for implementation (OECD, FAO, and UNCDF 2016). Differences within a territory – agroecosystemic and local priorities – need to be considered, as do opportunities to link rural and urban areas, e.g. through more direct interactions between consumers and producers (Vaarst et al. 2017).

Regarding experimentation by farmer-entrepreneurs, a number of barriers stand out: insecure land tenure, which hinders the adoption of agroecological practices (Bandiera 2007; Broegaard 2005; Harvey et al. 2017); severe land fragmentation, which is a severe impediment to the development of integrated farming systems (Dethier and Effenberger 2012; Isgren 2016; Levain et al. 2015); the absence of timely access to sufficient amounts of bio-inputs, including clean native seeds, organic fertilizers, and biological pest- and disease-management products; insufficient availability of rural manpower; insufficient access to credit when needed; and infrastructural difficulties in getting products to markets. These barriers could be addressed by organizations at different levels (e.g. seed propagation by local universities and by individual farmers diversifying into seed production). New arrangements could be made with large-scale ranchers to sell their excess manure to local cooperatives. Universities and INTA could be involved to investigate and produce biological pest- and disease-management products. Land fragmentation and tenure issues are subjects to be addressed by municipal or national government but could be discussed within villages first. Concerning on-farm adoption of agroecology, the impacts of parcel fragmentation have been more studied from a biodiversity perspective (Liere, Jha, and Philpott 2017; Perfecto, Vandermeer, and Wright 2009). Credit issues could be handled by the Banco Produzcamos, which is dependent on national government input or by credit schemes from local cooperatives. The implementation of a public procurement policy, together with the creation of an organization to bundle production, assume risks, and organize distribution to government centers, could be a tool to grow national markets. Barriers to private-sector involvement in the creation of market opportunities are many, and thus point to focusing on input provision (Henderson and Casey 2015) or on innovative ways of arranging markets for diverse products, such as direct contact between producers and consumers (Lanka, Khadaroo, and Böhm 2017; Vaarst et al. 2017). Beyond the discussion about if it is through

overprice or value chains that rentability could be improved, our results suggest that a “retail transformation” (Reardon et al. 2009), focusing on the health, nutrition, and environmental benefits of agroecological products, could be beneficial to agroecological farmers. As suggested by other authors, the valorization of ecosystem services provided by agroecology could serve as an entry point to increasing agroecology’s profitability to farmers (D’Annolfo et al. 2017; Dendoncker et al. 2018; Gliessman et al. 2012; Liere, Jha, and Philpott 2017; Ponisio and Ehrlich 2016). Further, synergies between agroecology and alternative opportunities, such as ecotourism, could be explored.

In Nicaragua, knowledge concerning the technological aspects of agroecology is growing more rapidly than the development of the associated necessary knowledge, physical, and financial infrastructures incentivizing agroecological production and creating consumer demand for agroecological products. As David and Bell (2018) note, instructors should be teaching processes, not just content (David and Bell 2018). In line with Vandermeer and Perfecto (2012), traditional knowledge from farmers and new knowledge generated in universities could be combined to form agroecological knowledge that is both deep and broad. We agree with Meek and Tarlau (2016) that critical food systems education, including praxis, policy, and pedagogy, is a path towards reflexive producers and consumers of agroecological products (Meek and Tarlau 2016). To grow consumer awareness of and demand for nationally-produced agroecological products, two avenues could be followed. First, following insights from Echegaray (2016), cooperatives and groups like the GPAE could better highlight their corporate social responsibility aspects, related to the ecological and social benefits of promoting agroecological products (Echegaray 2016). Second, an advertising campaign highlighting the benefits of an agroecologically-based agri-food system, emphasizing possible environmental, social, and health benefits, and identifying local points of sale, to air on the government-affiliated television and radio stations that broadcast nationwide. To support phenomenon-based learning processes (Francis et al. 2013), demonstration plots, which can be a driving factor in urban sustainability transitions (Werbelloff, Brown, and Loorbach 2016) and are used widely by farmer organizations in rural Nicaragua, could be placed in urban parks across the country as part of the government’s current program of public park rejuvenation. This could bolster agroecology’s legitimacy with the Nicaraguan public, particularly if agroecology is framed as an indicator of national sovereignty.

### **Conclusion: Understanding and supporting agroecological transitions**

Following the central research question – what are the barriers to the agroecological transition in Nicaragua? – we used a structural-functional TIS analysis to identify mechanisms that block the further diffusion of agroecology. We found that using the TIS approach aids in analyzing the growth of agroecology in a holistic manner. Based on results from our case

study in Nicaragua, we identified some central mechanisms blocking the agroecological transition: policy mismatches, inadequate mobilization of resources, and insufficient market development, which weaken entrepreneurial opportunities and experimentation. Although these blocking mechanisms hindering the diffusion of agroecology are strongly interlinked, the TIS analysis allowed us to pinpoint specific factors empowering these barriers. The results of this research highlight the coupled innovations that are necessary to drive agri-food systems sustainability transitions. A central factor is the fragmented institutional framework concerning agroecology, which inhibits a wide-spread perception of agroecology as a viable alternative to conventional agriculture, as well as hinders concrete actions that could incentivize stakeholders in the agroecological innovation system. Two other, strongly interlinked, factors are the lack of a common definition of agroecology, and the lack of a common vision amongst stakeholders for the development of agroecology vis-à-vis conventional agriculture. These factors open interesting avenues for future research, particularly concerning the power struggles during the development of common definitions of and vision for contested processes such as agri-food system sustainability transitions, the role of politics and the state in transition processes (Gonzalez de Molina 2013), and the role of individual and organizational agency in transitions. More generally, they indicate that research on transitions towards agroecology would benefit from insights gained from the use of systemic frameworks such as socio-technical systems approaches.

## Notes

1. This paper uses the definition of agroecology set forth by Francis et al. (2003): “Agroecology as the integrative study of the ecology of the entire food system, encompassing ecological, economic and social dimensions. [...] The definition expands our thinking beyond production practices and immediate environmental impacts at the field and farm level” (Francis et al. 2003, 100f).
2. For example, the development of clean water systems (Geels 2005), or the transition from coal to diverse energy technologies (Turnheim and Geels 2013).
3. Initial research was undertaken in 2014; follow-up research in 2016, 2017, and 2018 served to deepen and triangulate information from 2014, and, as agroecology is currently in a very dynamic phase, to investigate recent developments.
4. The results presented here are based in research that attempted to capture the points of view of farmers of all ages and genders. For the purposes of this article, farmer’s opinions were COHERENT across ages and genders, so we do not differentiate between women, men, and youth farmers.
5. See [gpaenicaragua.blogspot.com](http://gpaenicaragua.blogspot.com).
6. Although farmers participating in our study were targeted by gender and age, their opinions regarding issues pertaining to these seven functions were similar. Hence, we do not differentiate between male, female, and youth farmers in these results.

7. Although mainly for seeds for basic foodstuffs – maize, beans, and sorghum – some CSBs are now focusing on vegetable seeds as well.
8. See <http://semillasidentidad.blogspot.nl/2018/03/productores-de-mesoamerica.html>.
9. See <http://maonic.org/acerca/> for more information.
10. Composed in Nicaragua of the PCAC, SIMAS, GPAE, MAONIC, Centro Humboldt, and the National Table for Risk Management.
11. <http://unag.org.ni/alianza-por-la-agroecologia-quienes-somos/>.
12. The other current member is the Roundtable for Agriculture and Forest (MAF), which is formed by the ATC and five other organizations (MAF 2018).
13. The training was based in coffee, cacao, vegetable, and basic grain production, supported by the UNA and funded by the Food and Agricultural Organization of the United Nations (FAO) to support institutional capacity-building. It led to an ‘International degree in agroecological management with emphasis in food security’ (FAO 2016a, 2016b).
14. Organized by the national agricultural ministry (MAG), the national council would bring together representatives from organizations working in agroecology: four government ministries, INTA, two each from regional councils and universities, one representative from the private (post-harvest) sector, and four from farmer organizations. Highlighting the split between competing discourses on ecological agriculture, two would be from agroecological farmer organizations and two from organic organizations (GRUN 2011).
15. UNAG introduced agroecology to Nicaragua by inviting Mexican agroecologists in the late 1980s and was instrumental in the formation of LVC as well as in the formulation of the term ‘food sovereignty’ by LVC in the early 1990s (Edelman 2008; Godek 2014, 2015; Mier Y Terán Giménez Cacho et al. 2018; Toledo 2012). In the mid-1990s, it abandoned its agroecological program, but in recent years it has switched back to promoting agroecology alongside conventional agriculture and houses the farmer-to-farmer program (known as PCAC-UNAG).
16. See, for example, (Managuafuriosa.com 2015).
17. GPAE stresses that it has a brand to identify agroecologically produced products but does not certify producers (see <http://gpaenicaragua.blogspot.nl/search/label/CAPACITACIONES>).
18. Collective certification signifies that not only individual producers, but all farmers in a producer organization are certified, and is based on social control to maintain certification standards (see e.g. BioLatina’s handbook on quality control for group certification at [http://www.biolatina.com/doc\\_bl/org\\_informacion/GCI-240417.pdf](http://www.biolatina.com/doc_bl/org_informacion/GCI-240417.pdf), (last accessed April 4, 2018)). Recognizing that certification by itself is not sufficient to ensure food security of farming households (Bacon et al. 2008; Beuchelt and Zeller 2011; Fraser, Fisher, and Arce 2014), it is nonetheless a first step in the standardization of agroecological production units for marketing purposes and .
19. Documents show that, for example, the European Union, international non-governmental organizations (INGOs) (e.g. Heifer International, Catholic Relief Services), international solidarity organizations such as VECO Mesoamérica, foreign development agencies such as SwissAid, or the FAO fund agroecological projects and organizations in Nicaragua.
20. 800,000 Nicaraguans, or 10% of the population, live and work overseas, sending remittances (totaling around 10% of Nicaragua’s GDP in the first half of 2017) to support their families back home (BCN 2017).
21. Examples include: the ATC’s drive to create an agroecological corridor in the dry tropics of western Nicaragua; GPAE’s efforts to link disparate stakeholders across

territories; the creation of TLAs to provide a space for interaction and coordination between (agroecological) organizations in three areas in northern Nicaragua, an initiative led by the International Center for Tropical Agriculture (CIAT); and UNA work with ADAR on territorial development.

22. For example, the Mesa Orgánica promotes monocultures of export crops and input substitution, including the use of certain biological pest control and fertilizer products, while the Alliance for Agroecology aims to strengthen the legal base of national agroecological production while contributing to environmental conservation and restoration, the promotion of native seeds, and a firm stand against transgenic seeds. Within the GRUN, some entities conflate agroecology with organic agriculture (Fréguin-Gresh 2017), while they have divergent definitions in Law 765 (discussed above in the sub-section on guidance of the search).
23. For example, Wezel et al.'s split of agroecology into a science, a movement, and a practice (Wezel et al. 2009) and rebuttals against this (Rivera-Ferre 2018); the debate generated by FAO's High Level Panel of Experts open e-consultation on 'Agroecological approaches and other innovations for sustainable agriculture and food systems that enhance food security and nutrition'; and the debate attempting to conflate agroecology with Climate Smart Agriculture (e.g. Saj et al. 2017), which is rebutted (e.g. Pimbert 2015).

## Acknowledgments

This research was funded by the CGIAR Research Program on the Humid Tropics and the CGIAR Research Program on Roots, Tubers and Bananas. The authors gratefully acknowledge the help of all participants in this study.

## Funding

This work was supported by the CGIAR Research Program on the Humid Tropics and the CGIAR Research Program on Roots, Tubers and Bananas;

## ORCID

Katharina J.F. Schiller  <http://orcid.org/0000-0003-2196-1719>

Laurens Klerkx  <http://orcid.org/0000-0002-1664-886X>

P. Marijn Poortvliet  <http://orcid.org/0000-0002-8844-6669>

Wendy Godek  <http://orcid.org/0000-0003-1999-2778>

## References

- Alianza por la Agroecología. 2014. "Retos de La Agroecología y La Agricultura Familiar Campesina En Nicaragua."
- Altieri, M. A., and C. I. Nicholls. 2008. Scaling up agroecological approaches for food sovereignty in Latin America. *Development* 51 (4):472–80. doi:10.1057/dev.2008.68.
- Altieri, M. A., and C. I. Nicholls. 2012. Agroecology. Scaling up for food sovereignty and resiliency. *Sustainable Agriculture Reviews* 11:1–29. Edited by Eric Lichtfouse. doi:10.1007/978-94-007-5449-2.

- Altieri, M. A., and C. I. Nicholls. 2017. Agroecology : A brief account of its origins and currents of thought in Latin America. *Agroecology and Sustainable Food Systems* 41 (C):231–37. doi:10.1080/21683565.2017.1287147.
- Altieri, M. A., and V. M. Toledo. 2011. The agroecological revolution in Latin America: Rescuing nature, ensuring food sovereignty and empowering peasants. *The Journal of Peasant Studies* 38 (3):587–612. doi:10.1080/03066150.2011.582947.
- Amekawa, Y., H. Sseguya, S. Onzere, and I. Carranza. 2010. Delineating the multifunctional role of agroecological practices: toward sustainable livelihoods for smallholder farmers in developing countries. *Journal of Sustainable Agriculture* 34 (2):202–28. doi:10.1080/10440040903433079.
- Angeon, V., and M. Chave. 2014. Implementing the agroecological transition: Weak or strong modernization of agriculture? The example of the mycorrhiza supply Chain in France. In *54th Ersa congress: Regional development & globalisation: Best practices*, 1–20. Russia: Saint Petersburg.
- Araújo, S., and W. Godek. 2014. Opportunities and challenges for food sovereignty policies in Latin America: The case of Nicaragua. In *Rethinking food systems. structural challenges, new strategies and the law*, ed. C. S. Nadia, P. C. Lambek, A. Wong, and L. Brilmayer, 53–74. Dordrecht: Springer science and Business Media.
- Baca Castellón, L. 2015. Con Enfoque Agroecológico. *La Prensa* 2.
- Baca Castellón, L. 2018. La Agroecología Aún Es Materia Pendiente En Nicaragua. *La Prensa* 5..
- Bacon, C. M., V. Ernesto Méndez, M. E. F. Gómez, D. Stuart, and S. R. D. Flores. 2008. Are sustainable coffee certifications enough to secure farmer livelihoods? The millenium development goals and nicaragua’s fair trade cooperatives. *Globalization* 5 (2):259–74. doi:10.1080/14747730802057688.
- Bacon, C. M., W. A. Sundstrom, V. María Eugenia Flores Gómez, E. Méndez, R. Santos, B. Goldoftas, I. Dougherty, and M. E. F. Gómez. 2014. Explaining the ‘hungry farmer paradox’: Smallholders and fair trade cooperatives navigate seasonality and change in nicaragua’s corn and coffee markets. *Global Environmental Change* 25 (1):133–49. doi:10.1016/j.gloenvcha.2014.02.005.
- Bandiera, O. 2007. Land tenure, investment incentives, and the choice of techniques: Evidence from Nicaragua. *The World Bank Economic Review* 21 (3):487–508. doi:10.1093/wber/lhm005.
- World Bank, T. W. 2017. *World development indicators*. Washington, DC: The World Bank.
- BCN. 2017. Informe. Remesas Familiares. II Trimestre 2017. *Managua* : BancoCentral de Nicaragua (BCN), 1..
- Bellamy, A. S., and A. A. R. R. Ioris. 2017. Addressing the knowledge gaps in agroecology and identifying guiding principles for transforming conventional agri-food systems. *Sustainability (Switzerland)* 9 (3):1–17. doi:10.3390/su9030330.
- Bergek, A., S. Jacobsson, B. Carlsson, S. Lindmark, and A. Rickne. 2008. Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy* 37 (3):407–29. doi:10.1016/j.respol.2007.12.003.
- Beuchelt, T. D., and M. Zeller. 2011. Profits and poverty: Certification’s troubled link for nicaragua’s organic and fairtrade coffee producers. *Ecological Economics* 70 (7):1316–24. doi:10.1016/j.ecolecon.2011.01.005.
- Binz, C., B. Truffer, and L. Coenen. 2014. Why space matters in technological innovation systems - mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy* 43 (1):138–55. doi:10.1016/j.respol.2013.07.002.

- Birner, R. 2012. Module 7: Thematic note 2: Methods for organizational assessments in agricultural innovation systems. In World Bank, *Agricultural innovation systems: An investment sourcebook*, 553–61. Washington, DC: The World Bank.
- Blesh, J. M., and S. A. Wolf. 2014. Transitions to agroecological farming systems in the mississippi river basin: Toward an integrated socioecological analysis. *Agriculture and Human Values* 31 (4):621–35. doi:10.1007/s10460-014-9517-3.
- Blum, N. U., C. R. Bening, and T. S. Schmidt. 2015. An analysis of remote electric mini-grids in laos using the technological innovation systems approach. *Technological Forecasting & Social Change* 95:218–33. doi:10.1016/j.techfore.2015.02.002.
- Boone, K., and P. L. Taylor. 2016. Deconstructing homegardens: Food security and sovereignty in Northern Nicaragua. *Agriculture and Human Values* 33 (2):239–55. doi:10.1007/s10460-015-9604-0.
- Broegaard, R. J. 2005. Land tenure insecurity and inequality in Nicaragua. *Development and Change* 36 (5):845–64. doi:10.1111/j.0012-155X.2005.00438.x.
- Busse, M., W. Schwerdtner, R. Siebert, A. Doernberg, A. Kuntosch, B. König, and W. Bokelmann. 2015. Analysis of animal monitoring technologies in Germany from an innovation system perspective. *Agricultural Systems* 138 (July):55–65. doi:10.1016/j.agry.2015.05.009.
- Caron, P., E. Biénabe, and E. Hainzelin. 2014. Making transition towards ecological intensification of agriculture a reality: The gaps in and the role of scientific knowledge. *Current Opinion in Environmental Sustainability* 8 (October):44–52. doi:10.1016/j.cosust.2014.08.004.
- D' Annolfo, R., B. Gemmill-Herren, B. Graeub, and L. A. Garibaldi. 2017. A review of social and economic performance of agroecology. *International Journal of Agricultural Sustainability* 15 (6):632–44. doi:10.1080/14735903.2017.1398123.
- David, C., and M. M. Bell. 2018. New challenges for education in agroecology. *Agroecology and Sustainable Food Systems* 42 (6):1–8. doi:10.1080/21683565.2018.1426670.
- De Laiglesia, J. R. 2011. *Why do farmers sell their land? Evidence from Nicaragua*. Paris: OECD Development Centre.
- de Molina Manuel, G. 2013. Agroecology and politics. how to get sustainability? About the necessity for a political agroecology. *Agroecology and Sustainable Food Systems* 37 (1):45–59. doi:10.1080/10440046.2012.705810.
- Dendoncker, N., F. Boeraeve, E. Crouzat, M. Dufrêne, A. König, and C. Barnaud. 2018. How can integrated valuation of ecosystem services help understanding and steering agroecological transitions? *Ecology and Society* 23 (1):12. doi:10.5751/ES-09843-230112.
- Dethier, J.-J., and A. Effenberger. 2012. Agriculture and development: A brief review of the literature. *Economic Systems* 36 (2):175–205. doi:10.1016/j.ecosys.2011.09.003.
- Duru, M., T. Olivier, and M. Fares. 2015. Designing agroecological transitions; A review. *Agronomy for Sustainable Development* 35 (4):0–22. doi:10.1007/s13593-015-0318-x.
- Eastwood, C. R., D. F. Chapman, and M. S. Paine. 2012. Networks of practice for co-construction of agricultural decision support systems: case studies of precision dairy farms in Australia. *Agricultural Systems* 108 (C):10–18. doi:10.1016/j.agry.2011.12.005.
- Echegaray, F. 2016. Corporate mobilization of political consumerism in developing societies. *Journal of Cleaner Production* 134:124–36. doi:10.1016/j.jclepro.2015.07.006.
- Edelman, M. 2008. Transnational organizing in Agrarian Central America: Histories, challenges, prospects. *Journal of Agrarian Change* 8 (2–3):229–57. doi:10.1111/j.1471-0366.2008.00169.x.
- Evans, J., and P. Jones. 2011. The walking interview: Methodology, mobility and place. *Applied Geography* 31 (2):849–58. doi:10.1016/j.apgeog.2010.09.005.

- FAO. 2015. Agroecology for food security and nutrition: Proceedings of the FAO international symposium. 406.
- FAO. 2016a. “Fortalecimiento de Capacidades Técnicas Del Sistema Nacional de Producción, Consumo y Comercio En Agroecología (SNPCC).”
- FAO. 2016b. Gobierno de Nicaragua Avanza En La Implementación de Un Modelo Agroecológico Mediante La Formación de Alto Nivel de Sus Talentos Humanos. 2016. <http://www.fao.org/family-farming/detail/es/c/429636/>.
- Francis, C. A., T. A. Breland, E. Østergaard, G. Lieblein, and S. Morse. 2013. Phenomenon-based learning in agroecology: A prerequisite for transdisciplinarity and responsible action. *Journal of Sustainable Agriculture* 37 (1):60–75. doi:10.1080/10440046.2012.717905.
- Francis, Charles A., Geir Lieblein, Stephen R. Gliessman, T a Breland, N Creamer, R R Harwood, L. Salomonsson, et al. 2003. Agroecology: The ecology of food systems. *Journal of Sustainable Agriculture* 22 (3):99–118. doi:10.1300/J064v22n03.
- Fraser, J., E. Fisher, and A. Arce. 2014. Reframing ‘Crisis’ in fair trade coffee production: Trajectories of Agrarian Change in Nicaragua. *Journal of Agrarian Change* 14 (1):52–73. doi:10.1111/joac.12014.
- Fréguin-Gresh, S. 2017. Agroecología y Agricultura Orgánica En Nicaragua. Génesis, Institucionalización y Desafíos. In *Políticas Públicas a Favor de La Agroecología En América Latina y El Caribe*, 174–95. Red Políticas Publicas en América Latina y el Caribe. Porto Alegre: Evangraf/Criacao Humana, Red PP-AL, FAO
- Fundación Luciérnaga, and SIMAS. 2010. *Soberanía y Seguridad Alimentaria En Nicaragua: Causas y Efectos*. Managua: Fundación Luciérnaga and SIMAS.
- Gaitán-Cremaschi, D., L. Klerkx, J. H. Jessica Duncan, C. H. Trienekens, M. E. C. Santiago Dogliotti, and A. H. R. Walter. 2019. Characterizing Diversity Of Food Systems In View Of Sustainability Transitions. A review. *Agronomy for Sustainable Development* 39 (1):1. doi:10.1007/s13593-018-0550-2.
- Garb, Y., and L. Friedlander. 2014. From transfer to translation: Using systemic understandings of technology to understand drip irrigation uptake. *Agricultural Systems* 128 (C):13–24. doi:10.1016/j.agsy.2014.04.003.
- Geels, F. W. 2005. Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850-1930) - A case study in multi-level perspective. *Technology in Society* 27 (3):363–97. doi:10.1016/j.techsoc.2005.04.008.
- Giraldo, O. F., and P. M. Rosset. 2017. Agroecology as a territory in dispute: Between institutionality and social movements. *The Journal of Peasant Studies* 1–20. doi:10.1080/03066150.2017.1353496.
- Gliessman, S. R., M. Rosemeyer, L. S. Hundal, S. R. Gliessman, and M. Rosemeyer. 2012. The conversion to sustainable agriculture. In ed., S. R. Gliessman and M. Rosemeyer, 3–14 *Journal of Environmental Quality. Principles, processes, and practices*. Vol. 41. Boca Raton: The American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, Inc. doi:10.2134/jeq2012.0002br.
- Gliessman, S. R. 2017. A brief history of agroecology in Spain and Latin America. *Agroecology and Sustainable Food Systems* 41 (3–4):229–30. doi:10.1080/21683565.2017.1292390.
- Godek, W. 2013. The complexity of food sovereignty policymaking: The case of Nicaragua’s Law 693. In Yale University Press, *Food Sovereignty: A Critical Dialogue*. New Haven, CN: Program in Agrarian Studies, Yale University.
- Godek, W. 2014. *The Institutionalization of food sovereignty: The case of Nicaragua’s law of food and nutritional sovereignty and security*. Rutgers: The State University of New Jersey.
- Godek, W. 2015. Challenges for food sovereignty policy making: The case of Nicaragua’s law 693. *Third World Quarterly* 36 (3):526–43. doi:10.1080/01436597.2015.1005437.



- Gonzalez, R. A., J. Thomas, and M. Chang. 2018. Translating agroecology into policy: The Case of France and the United Kingdom. *Sustainability* 10: 1–19. doi:10.3390/su10082930.
- González, V., F. Salmerón-Miranda, and E. Zamora. 2015. La Agroecología En Nicaragua: La Praxis Por Delante de La Teoría. *Agroecología* 10 (2):19–28.
- GPAE. 2013. “Quienes Somos.” [http://gpaenicaragua.blogspot.com/search/label/QUIENES SOMOS](http://gpaenicaragua.blogspot.com/search/label/QUIENES_SOMOS).
- GRUN. 2011. *Ley No. 765. Ley de Fomento a La Producción Agroecológica u Orgánica. La Gaceta. Diario Oficial*. Nicaragua: Nicaraguan Government of Reconciliation and National Unity (GRUN).
- GRUN. 2012. *Norma Técnica Obligatoria Nicaragüense. Caracterización, Regulación y Certificación de Unidades de Producción Agro Ecológica (NTON 11-037)*. Nicaragua: Nicaraguan Government of Reconciliation and National Unity (GRUN).
- Gutiérrez, N. C. 2017. “Vegetales Orgánicos Para Una Alimentación Más Sana.” *El Nuevo Diario*, June 11, 2017.
- Hansen, U. E., and I. Nygaard. 2013. Transnational linkages and sustainable transitions in emerging countries: Exploring the role of donor interventions in niche development. *Environmental Innovation and Societal Transitions* 8:1–19. doi:10.1016/j.eist.2013.07.001.
- Harvey, C. A., M. Ruth Martínez-Rodríguez, J. Mario Cárdenas, J. Avelino, B. Rapidel, R. Vignola, C. I. Donatti, and S. Vilchez-Mendoza. 2017. The Use Of Ecosystem-Based Adaptation Practices By Smallholder Farmers In Central America. *Agriculture, Ecosystems & Environment* 246 (April):279–90. doi:10.1016/j.agee.2017.04.018.
- Hekkert, M. P., R. A. A. Suurs, O. Simona, S. K. Negro, and R. E. H. M. Smits. 2007. Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change* 74 (4):413–32. doi:10.1016/j.techfore.2006.03.002.
- Hekkert, M. P., and S. O. Negro. 2009. Functions of innovation systems as a framework to understand sustainable technological change: Empirical evidence for earlier claims. *Technological Forecasting & Social Change* 76 (4):584–94. doi:10.1016/j.techfore.2008.04.013.
- Henderson, C., and J. Casey. 2015. *Scaling up Agroecology through Market Systems*. Rugby, Warwickshire: Practical Action. doi:10.3362/9781780446554.
- Herrera, C. 2014. Tres Décades Desarrollando La Agroecología. In *Agroecología. Un Aporte a La Soberanía Alimentaria*. 16–18. Managua: Noticias Aliadas. [www.noticiasaliadas.org](http://www.noticiasaliadas.org).
- Holt-Giménez, E., and M. A. Altieri. 2013. Agroecology, food sovereignty and the new green revolution. *Agroecology and Sustainable Food Systems* 37 (1):90–102. doi:10.1080/10440046.2012.716388.
- IFPRI, and IICA. 2008. *Agricultural R&D in Central America - policy, investments, and institutional profile*. Washington, DC and Managua: International Food Policy Research Institute (IFPRI) and Inter-American Institute for Cooperation in Agriculture (IICA).
- IICA, M. A. G. F. O. R., and C. Austriaca. 2009. *Estado de La Agricultura Orgánica En Nicaragua. Propuesta Del Movimiento Orgánico Para Su Fomento y Desarrollo*. Managua: Inter-American Institute for Cooperation in Agriculture (IICA), Ministerio Agropecuario y Forestal (MAGFOR) and Cooperación Austriaca.
- Ingram, J. 2017. Agricultural transition: Niche and regime knowledge systems’ boundary dynamics. *Environmental Innovation and Societal Transitions* (April):1–19. doi:10.1016/j.eist.2017.05.001.
- Intarakumnerd, P., and C. Chaminade. 2007. Strategy versus practice in innovation systems policy: The case of Thailand. *Asian Journal of Technology Innovation* 15 (2):197–213. doi:10.1080/19761597.2007.9668643.

- Isgren, E. 2016. No quick fixes: four interacting constraints to advancing agroecology in Uganda. *International Journal of Agricultural Sustainability* (March):1–20. doi:10.1080/14735903.2016.1144699.
- Isgren, E., and B. Ness. 2017. Agroecology to promote just sustainability transitions: Analysis of a civil society network in the Rwenzori Region, Western Uganda. *Sustainability (Switzerland)* 9:8. doi:10.3390/su9081357.
- Izaguirre, M., and P. Enrique. 2017. Investigación Agropecuaria Con Enfoque Agroecológico Para El Desarrollo de Una Agricultura Sostenible En Nicaragua. *La Calera* 17 (28):43–45. doi:10.5377/calera.v17i28.6369.
- Kebebe, E., A. J. Duncan, L. Klerkx, I. J. M. de Boer, and S. J. Oosting. 2015. Understanding socio-economic and policy constraints to dairy development in Ethiopia: A coupled functional-structural innovation systems analysis. *Agricultural Systems* 141 (C):69–78. doi:10.1016/j.agsy.2015.09.007.
- Khadse, A., P. M. Rosset, H. Morales, and B. G. Ferguson. 2017. Taking agroecology to scale: The zero budget natural farming peasant movement in Karnataka, India. *The Journal of Peasant Studies* 6150 (April):1–28. doi:10.1080/03066150.2016.1276450.
- Kilelu, C. W., L. Klerkx, and C. Leeuwis. 2013. Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme. *Agricultural Systems* 118 (C):65–77. doi:10.1016/j.agsy.2013.03.003.
- Klerkx, L., B. van Mierlo, and C. Leeuwis. 2012. Evolution of systems approaches to agricultural innovation: concepts, analysis and interventions. In *Farming systems research into the 21st century: The new dynamic*, ed. Darnhofer, I., Gibbon, D., and Dedieu, B. 457–83. Dordrecht: Springer Netherlands. doi:10.1007/978-94-007-4503-2\_20.
- Lamprinopoulou, C., A. Renwick, L. Klerkx, F. Hermans, and D. Roep. 2014. Application of an integrated systemic framework for analysing agricultural innovation systems and informing innovation policies: Comparing the Dutch and Scottish Agrifood Sectors. *Agricultural Systems* 129 (June):40–54. doi:10.1016/j.agsy.2014.05.001.
- Landero, B., S. Obando, F. Salmerón, L. Valverde, and E. Vivas. 2016. Agricultura Sostenible Para Enfrentar Los Efectos Del Cambio Climático En Nicaragua. In eds., Elgin Vivas and Nehemías Obed López Carrión. Managua: Fundación Friedrich Ebert.
- Lanka, S. V., I. Khadaroo, and B. Steffen. 2017. Agroecology accounting: Biodiversity and sustainable livelihoods from the margins. *Accounting, Auditing & Accountability Journal* 30 (7):1592–613. doi:10.1108/AAAJ-12-2015-2363.
- Levain, A., F. Vertès, L. Ruiz, L. Delaby, C. Gascuel-Oudou, and M. Barbier. 2015. ‘I Am an Intensive Guy’: The possibility and conditions of reconciliation through the ecological intensification framework. *Environmental Management* 56 (5):1184–98. doi:10.1007/s00267-015-0548-3.
- Levidow, L., M. Pimbert, and G. Vanloqueren. 2014. Agroecological research: Conforming— Or transforming the dominant agro-food regime? *Agroecology and Sustainable Food Systems* 38 (10):1127–55. doi:10.1080/21683565.2014.951459.
- Liere, H., S. Jha, and S. M. Philpott. 2017. Intersection between biodiversity conservation, agroecology, and ecosystem services. *Agroecology and Sustainable Food Systems* 41 (7):723–60. doi:10.1080/21683565.2017.1330796.
- MAF. 2018. “Mesa Agropecuaria y Forestal (MAF).” GLOOBAL. <http://www.gloobal.net/iepala/gloobal/fichas/ficha.php?id=30527&entidad=Agentes&html=1>.
- MAGFOR. 2013. “Documento Final Del Estudio de Políticas Agroambientales de Nicaragua,” May. Managua: [managuafuriosa.com](http://www.managuafuriosa.com).
- Managua: <http://www.managuafuriosa.com/consumo-si-local/>.

- MAONIC. 2011. *Fomento a La Producción Agroecológica y Orgánica En Nicaragua*. Managua: MAONIC and SIMAS.
- Markard, J., and B. Truffer. 2008. Technological innovation systems and the multi-level perspective: Towards an integrated framework. *Research Policy* 37 (4):596–615. doi:10.1016/j.respol.2008.01.004.
- McCune, N. 2016. Family, territory, nation: Post-neoliberal agroecological scaling in Nicaragua. *Food Chain* 6 (2):92–106. doi:10.3362/2046-1887.2016.008.
- McCune, N., P. M. Rosset, T. C. Salazar, A. S. Moreno, and H. Morales. 2016. Mediated territoriality: Rural workers and the efforts to scale out agroecology in Nicaragua. *The Journal of Peasant Studies*. 1–23. doi:10.1080/03066150.2016.1233868.
- Meek, D. 2016. The cultural politics of the agroecological transition. *Agriculture and Human Values* 33 (April):275–90. doi:10.1007/s10460-015-9605-z.
- Meek, D., and R. Tarlau. 2016. Critical Food Systems Education (CFSE): Educating for food sovereignty. *Agroecology and Sustainable Food Systems* 40 (3):237–60. doi:10.1080/21683565.2015.1130764.
- Meynard, J.-M., M.-H.-H. Jeuffroy, M. L. Bail, A. Lefèvre, M.-B.-B. Magrini, and C. Michon. 2017. Designing coupled innovations for the sustainability transition of agrifood systems. *Agricultural Systems* 157 (August):330–39. doi:10.1016/j.agsy.2016.08.002.
- Michelson, H. C., T. Reardon, and F. Perez. 2012. Small farmers and big retail: Trade-offs of supplying supermarkets in Nicaragua. *World Development* 40 (2):342–54. doi:10.1016/j.worlddev.2011.07.013.
- Mier Y Terán Giménez Cacho, M., O. F. Giraldo, M. Aldasoro, H. Morales, B. G. Ferguson, P. M. Rosset, A. Khadse, and C. Campos. 2018. Bringing agroecology to scale: Key drivers and emblematic cases. *Agroecology and Sustainable Food Systems* 42 (6):1–29. doi:10.1080/21683565.2018.1443313.
- Miles, A., M. S. DeLonge, and L. Carlisle. 2017. Triggering a positive research and policy feedback cycle to support a transition to agroecology and sustainable food systems. *Agroecology and Sustainable Food Systems* 41 (7):855–79. doi:10.1080/21683565.2017.1331179.
- Montenegro de Wit, M., and A. Iles. 2016. Toward thick legitimacy: Creating a web of legitimacy for agroecology. *Elementa: Science of the Anthropocene* 4:000115. doi:10.12952/journal.elementa.000115.
- Musioliik, J., and J. Markard. 2011. Creating and shaping innovation systems: Formal networks in the innovation system for stationary fuel cells in Germany. *Energy Policy* 39 (4):1909–22. doi:10.1016/j.enpol.2010.12.052.
- Nuevo Diario, E. 2017. “Productores Ofertarán Alimentos Agroecológicos.” *El Nuevo Diario*, June 19, 2017. <http://unag.org.ni/productores-ofertaran-alimentos-agroecologicos/>.
- OECD, FAO, and UNCDF. 2016. *Adopting a territorial approach to food security and nutrition policy*. Paris: OECD Publishing. doi:10.1787/9789264257108-en.
- Ollivier, G., D. Magda, A. Mazé, G. Plumecocq, and C. Lamine. 2018. Agroecological transitions: What can sustainability transition frameworks teach us? An Ontological and empirical analysis. *Ecology and Society* 23 (2):18. doi:10.5751/ES-09952-230205.
- Pant, L. P. 2016. Paradox of mainstreaming agroecology for regional and rural food security in developing countries. *Technological Forecasting and Social Change* 111 (March):305–16. doi:10.1016/j.techfore.2016.03.001.
- Pant, L. P., K. B. Kc, E. D. G. Fraser, P. K. Shrestha, A. B. Lama, S. K. Jirel, and P. Chaudhary. 2014. Adaptive transition management for transformations to agricultural sustainability in the Karnali Mountains of Nepal. *Agroecology and Sustainable Food Systems* 38 (2014):1156–83. doi:10.1080/21683565.2014.942022.

- PCAC, UNAG, and IDS. 2017. *Report on the challenges for the implementation of a transition process from conventional to agroecological farming in Nicaragua*. Brighton: the Institute of Development Studies (IDS).
- Perfecto, I., J. Vandermeer, and A. Wright. 2009. *Nature's matrix. Linking agriculture, conservation and food sovereignty*. London: Earthscan.
- Pimbert, M. 2015. Agroecology as an alternative vision to conventional development and climate-smart agriculture. *Development* 58 (2–3):286–98. doi:10.1057/s41301-016-0013-5.
- Piraux, M., L. Silveira, P. Diniz, and G. Duque. 2010. La Transition Agroecologique Comme Une Innovation Socio-Territoriale. Le Cas Du Territoire de La Borborema Dans Le Semi-Aride Bresilien. In *ISDA 2010*. Montpellier: International Symposium1–9.
- Ponisio, L. C., and P. R. Ehrlich. 2016. Diversification, yield and a new agricultural revolution: Problems and prospects. *Sustainability (Switzerland)* 8 (11):1–15. doi:10.3390/su8111118.
- Prensa, L. 2015. “Con Las Manos En La Tierra.” *La Prensa*, October 29, 2015.
- Ramos-Mejía, M., L. Maria Franco-Garcia, and J. M. Jauregui-Becker. 2018. Sustainability transitions in the developing world: Challenges of socio-technical transformations unfolding in contexts of poverty. *Environmental Science and Policy* 84:217–23. doi:10.1016/j.envsci.2017.03.010.
- Reardon, T., C. B. Barrett, J. A. Berdegue, and J. F. M. Swinnen. 2009. Agrifood Industry Transformation and Small Farmers in Developing Countries. *World Development*, 37(11): 1717–27..
- Ripoll, S. 2018. As good as it gets? The new sandinismo and the co-option of emancipatory rural politics in Nicaragua. In *ERPI 2918 international conference. Authoritarian populism and the rural world*, 16. The Netherlands: International Institute of Social Studies (ISS)..
- Rivera-Ferre, M. G. 2018. The resignification process of agroecology: competing narratives from governments, civil society and intergovernmental organizations. *Agroecology and Sustainable Food Systems* 42 (6):666–85. doi:10.1080/21683565.2018.1437498.
- Sabourin, E., M. M. Patrouilleau, J. F. Le Coq, L. Vásquez, and P. Niederle. 2017. *Políticas Públicas a Favor de La Agroecología En América Latina Y El Caribe*. Porto Alegre: Evangraf/Criacao Humana, Red PP-AL, FAO.
- Saj, S., E. Torquebiau, E. Hainzelin, J. Pages, and F. Maraux. 2017. The way forward: An agroecological perspective for climate-smart agriculture. *Agriculture, Ecosystems & Environment* 250 (July):20–24. doi:10.1016/j.agee.2017.09.003.
- Salazar-Centeno, D. 2013. Nicaragua: Potencial Faro Regional Para El Diseño y Evaluación de Agroecosistemas Agrocológicos. *La Calera* 13 (20):58–65. <http://revistasnicaragua.net.ni/index.php/CALERA/article/view/656/628>.
- Saravia-Matus, S. L., and J. Saravia-Matus. 2009. Agrarian Reform: Theory & Practice. The Nicaraguan Experience. *Encuentro 2009 Año XLI* (84):21–43.
- Schipanski, Meagan E., Graham K. MacDonald, 2016. Realizing resilient food systems. *BioScience* 66 (7):600–10. doi:10.1093/biosci/biw052.
- Schot, J., and F. W. Geels. 2008. Strategic niche management and sustainable innovation journeys: Theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management* 20 (5):537–54. doi:10.1080/09537320802292651.
- Schut, M., L. Klerkx, J. Kamanda, M. Sartas, and C. Leeuwis. 2018. *Innovation platforms: synopsis of innovation platforms in agricultural research and development*. *Encyclopedia of food security and sustainability*, eds. Ferranti, P., Berry, E., and Jock, A. Amsterdam: Elsevier. doi:10.1016/B978-0-12-812687-5.22197-7.
- Silici, L. 2014. *Agroecology. What It Is and What It Has to Offer*. London: International Institute for Environment and Development.

- SIMAS. 2011a. *Tratados de Libre Comercio y Su Impacto Sobre La Capacidad de Los Pequeños Productores de Nicaragua Para Tomar Decisiones Acertadas En Frente a Los Mercados Globalizados*. Managua: Mesoamerican Agricultural Information Service (SIMAS).
- SIMAS. 2011b. *Políticas Nacionales y Su Impacto Sobre La Capacidad de Los Pequeños Productores Nicaragüenses Para Tomar Decisiones Acertadas Frente a Los Mercados Globalizados*. Managua: Mesoamerican Agricultural Information Service(SIMAS)..
- SIMAS, and PCAC-UNAG. 2015. *De La Práctica Agroecológica En La Finca a La Incidencia Política. Seis Experiencias En San Ramón, Nicaragua*. Managua: Alianza por la Agroecología..
- Sixt, G. N., L. Klerkx, and T. S. Griffin. 2017. Transitions in water harvesting practices in Jordan's rainfed agricultural systems: Systemic problems and blocking mechanisms in an emerging technological innovation system. *Environmental Science and Policy* 84 (July):235–49. doi:10.1016/j.envsci.2017.08.010.
- Somarriba, Eduardo, John Beer, Julio Alegre-Orihuela, and Hernán J Andrade 2012. Mainstreaming agroforestry in Latin America. In *Agroforestry - the future of global land use*, ed. Ramachandran Nair, P.K. and Garrity, D. Dordrecht: Springer Netherlands, 429–53.
- Strauss, A. L., and J. M. Corbin. 1990. Grounded theory research: procedures, canons, and evaluative criteria. *Qualitative Sociology* 13 (1):3–21. doi:10.1007/BF00988593.
- Teixeira, H. M., L. Van Den Berg, I. M. Cardoso, A. J. Vermue, F. J. J. A. Bianchi, M. Peña-Claros, and P. Tittonell. 2018. Understanding farm diversity to promote agroecological transitions. *Sustainability* 10 (4337):20. doi:10.3390/su10124337.
- Thiemann, L. 2015. Operationalising food sovereignty through an investment lens: How agro-ecology is putting 'big Push Theory' back on the table. *Third World Quarterly* 36 (3):544–62. doi:10.1080/01436597.2015.1023568.
- Timonen, V., G. Foley, and C. Conlon. 2018. Challenges when using grounded theory: A pragmatic introduction to doing GT research. *International Journal of Qualitative Methods* 17 (1):1–10. doi:10.1177/1609406918758086.
- Tittonell, P., L. Klerkx, F. Baudron, G. F. Félix, A. Ruggia, D. van Apeldoorn, S. Dogliotti, P. Mapfumo, and A. H. R. Walter. 2016. Ecological intensification: local innovation to address global challenges. In *Sustainable agriculture reviews*, ed. E. Lichtfouse, 1–34. Berlin: Springer Science+Business Media.
- Toledo, V. M. 2012. La Agroecología En Latinoamerica: Tres Revoluciones, Una Misma Transformación. *Agroecología* 6 (3):37–46. doi:10.1080/03066150.2011.582947.
- Turnheim, B., and F. W. Geels. 2013. The destabilisation of existing regimes: Confronting a multi-dimensional framework with a case study of the british coal industry (1913-1967). *Research Policy* 42 (10):1749–67. doi:10.1016/j.respol.2013.04.009.
- Vaarst, Mette, Arthur Getz Escudero, Michael Jahi Chappell, Catherine Brinkley, Ravic Nijbroek, Nilson A.M. Arraes, Lise Andreasen, et al. 2017. Exploring the concept of agroecological food systems in a city-region context. *Agroecology and Sustainable Food Systems* 42(October). 21683565.2017.1365321. doi:10.1080/21683565.2017.1365321.
- van Mierlo, B., C. Leeuwis, and R. E. H. M Smits, and Woolthuis, R. K. (2010). Learning towards system innovation: Evaluating a systemic instrument. *Technological Forecasting and Social Change* 77(2), 318–334. <https://doi.org/10.1016/j.techfore.2009.08.004>
- Vandermeer, J., and I. Perfecto. 2012. Complex traditions: Intersecting theoretical frameworks in agroecological research. *Journal of Sustainable Agriculture* 3565 (May 2013):120911083004002. doi:10.1080/10440046.2012.717904.
- Villanueva, C., C. Sepúlveda, and M. Ibrahim. 2011. *Manejo Agroecológico Como Ruta Para Lograr La Sostenibilidad de Fincas Con Café y Ganadería*. Turrialba: Centro Agronómico Tropical de Investigación y Enseñanza, CATIE. doi:10.1080/14747730802057688.

- Weber, K. M., and H. Rohracher. 2012. Legitimizing research, technology and innovation policies for transformative change: Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework. *Research Policy* 41 (6):1037–47. doi:10.1016/j.respol.2011.10.015.
- Werbelloff, L., R. Brown, and D. Loorbach. 2016. Pathways of system transformation: Strategic agency to support regime change. *Environmental Sc* 66:119–28. doi:10.1016/j.envsci.2016.08.010.
- Wezel, A., M. Casagrande, F. Celette, J. F. Vian, A. Ferrer, and P. Joséphine. 2014. Agroecological practices for sustainable agriculture. A review. *Agronomy for Sustainable Development* 34 (1):1–20. doi:10.1007/s13593-013-0180-7.
- Wezel, A., T. Stéphane Bellon, D. C. Francis, D. Vallod, and C. David. 2009. Agroecology as a science, a movement and a practice. *Agronomy for Sustainable Development* 29:503–15. Springer Netherlands. doi:10.1051/agro/2009004.
- Wibbelmann, M., U. Schmutz, J. Wright, D. Udall, D. Rayns, M. Kneafsey, L. Trenchard, J. Bennett, and M. Lennartsson. 2013. *Mainstreaming agroecology: Implications for global food and farming systems*. Coventry: Centre for Agroecology and Food Security Discussion Paper. doi:10.13140/RG.2.1.1047.5929.
- Wieczorek, A. J., and M. P. Hekkert. 2012. Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars. *Science and Public Policy* 39 (1):74–87. doi:10.1093/scipol/scr008.
- Wieczorek, A. J., S. O. Negro, R. Harmsen, G. J. Heimeriks, L. Luo, and M. P. Hekkert. 2013. A review of the european offshore wind innovation system. *Renewable and Sustainable Energy Reviews* 26 (C):294–306. doi:10.1016/j.rser.2013.05.045.
- Woolthuis, K., M. L. Rosalinde, and V. Gilsing. 2005. A system failure framework for innovation policy design. *Technovation* 25 (6):609–19. doi:10.1016/j.technovation.2003.11.002.