

From Agribusiness to Agroecology and the Transition towards a Sustainable Food System in Panama



De los agronegocios a la agroecología y la transición hacia un sistema alimentario sostenible en Panamá

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Abstract: *Agriculture plays a primary role in Panama's economy. The country boasts a variety of farming operations, with cattle (milk and meat), swine, poultry, aquaculture production systems, in addition to rice, coffee, banana, teak and pineapple plantations. Massive land use changes have been occurring in a few decades due also to large expansions of agriculture in Panama. For example, although 25% of the country (1.8 million ha.) is considered suitable for farming, in 2017 it was estimated that 2.9 million ha., were cultivated, legitimizing this agricultural intensification by population growth, which at a rate of 1.4% yearly, has been spurring foods consumption and demand. Agribusiness leads Panama's agriculture yet, this mode of production has intensified a use of agrichemicals that have deteriorated land and water resources, causing additional pollution, sedimentation, and soil erosion. Climate change and a lack of land-use regulations that should be protective of biodiversity and family farms constitute grave sources of instability that paradoxically, affect domestic food security. This work reviewed changes that have occurred to Panama's landscape and its natural resources, in the last three decades. The environmental costs for retaining agricultural competitiveness in the global market continue to deteriorate the country's ecology. However, attempts towards an establishment of agroecology and other models of sustainable farming are notable, in attempting to avert the impacts caused by an intensification of agriculture. Although these efforts remain limited, they demonstrate an increasing interest for agroecology by farmers and an understanding for wanting to achieve a better balance between agriculture, food sovereignty and quality of life. Policies and governmental incentives to assist landowners operating a transition toward agroecology and implications for education reform in the agricultural sciences were considered as well, to highlight the complexity of developing a sustainable food system in Panama.*

Keywords: Agribusiness, agroecology, food systems, Panama, resilience..

Resumen: *La agricultura juega un papel primario en la economía de Panamá. El país cuenta con una variedad de empresas agropecuarias, con sistemas de producción ganadera (leche y carne), porcina, avícola, acuícola, además de plantaciones de arroz, café, banano, teca y piña. Se han producido cambios masivos en el uso de la tierra en unas pocas décadas debido también a la gran expansión de la agricultura en Panamá. Por ejemplo, aunque el 25% del país (1,8 millones de ha.) se considera apto*

para la agricultura, en el 2017 se estimó que se cultivaban 2,9 millones de ha., legitimándose esta intensificación agrícola por el crecimiento demográfico, que a una tasa del 1,4% anual, ha estado estimulando el consumo y la demanda de alimentos. La agricultura industrial lidera la agricultura de Panamá, sin embargo, este modo de producción ha intensificado el uso de agroquímicos que han deteriorado los recursos de la tierra y el agua, causando contaminación adicional, sedimentación y erosión del suelo. El cambio climático y la falta de regulaciones sobre el uso de la tierra que deberían proteger la biodiversidad y la agricultura familiar constituyen fuentes graves de inestabilidad que, paradójicamente, afectan la seguridad alimentaria interna. Este trabajo revisó los cambios que han ocurrido en el paisaje de Panamá y sus recursos naturales, en las últimas tres décadas. Los costos ambientales para mantener la competitividad agrícola en el mercado global continúan deteriorando la ecología del país. Sin embargo, son notables los intentos de instaurar la agroecología y otros modelos de agricultura sostenible, en un intento de evitar los impactos causados por una intensificación de la agricultura. Aunque estos esfuerzos siguen siendo limitados, demuestran un interés creciente por la agroecología por parte de los agricultores y una comprensión por querer lograr un mejor equilibrio entre la agricultura, la soberanía alimentaria y la calidad de vida. También se consideraron las políticas y los incentivos gubernamentales para ayudar a los terratenientes que operan una transición hacia la agroecología y las implicaciones para la reforma educativa en las ciencias agrícolas, para resaltar la complejidad de desarrollar un sistema alimentario sostenible en Panamá.

Palabras clave: Agronegocios, agroecología, sistemas alimentarios, Panamá, resiliencia..

1. INTRODUCTION

Panama is a world hotspot for biological diversity, which intermingles with a variety of human cultures, ecosystems and approaches to farming (Fig. 1). Current human pressures on the environment, the effects of global climate change and the recent consequences caused by the Covid-19 pandemic demand strategies in agriculture that are regenerative and more conservative of natural resources.

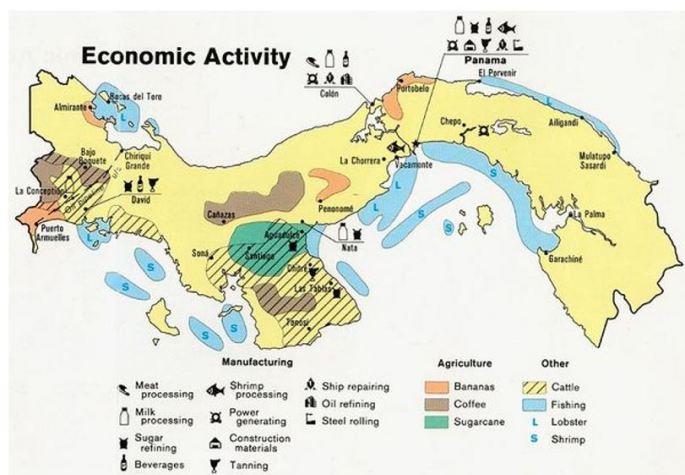


Fig 1. Economic map of Panama and its agricultural production regions (From: Wikipedia.org).

FIG 1

Economic map of Panama and its agricultural production regions

From: Wikipedia.org

Panama is the isthmus country (located between 7°12' and 9°38' north, 77°09' and 83°03' west), bordering with the Caribbean Sea (North), the Pacific Ocean (South), Colombia (East) and Costa Rica (West). The country has an area of 75,845.072 Km² (whose 30% is farmland) and is located at the center of the American continent, connecting north and south America (Zachrisson et al. 2017).

Agriculture was the country leading economic activity in the 1960s, employing 46% of its population in 1965 yet, since the construction of the Panama's canal its GDP shares declined from 29% in 1950 to 9% in 1985 and employment in agriculture dropped 26% (Tollefson 1989). However, Panama's food system remains very diverse, from livestock, fishery, aquaculture, to vegetables, rice, and tropical fruits (Camargo Buitrago et al. 2016). Despite of this abundance, a significant segment of its populations remains food insecure, with children under 5 years of age being particularly vulnerable to malnutrition. The World Bank reported that in Panama, 33.33% of children suffer various forms of malnutrition, both acute and chronic (Trading Economics 2019). According to data from the World Health Organization (WHO), death caused by malnutrition reached 151 or 0.85% of total deaths, which was equivalent to 3.45 deaths per 100,000 people in 2018. These data suggest that despite an intensification of farming achieved in the last 25 years to become more competitive on the global scale, agriculture has impoverished large segments of its population, rather than improving food security and quality of life. However, it maintains a keystone role in Panama's economy, with 14.5 % of its labor workforce employed in it in 2017, and with its western province of Chiriquí producing 80% of the national agricultural output (Embassy of the Kingdom of the Netherlands 2018).

The purpose of this work aimed at unraveling the complexity and paradoxes of Panama's food system, documenting efforts for better understanding the challenges, but also the opportunities to ensure food security to all its inhabitants. A plethora of empirical research exists already (Altieri et al. 2012; Altieri and Nicholls 2018; Ferguson and Morales 2010) to substantiate the environmental and socioeconomic benefits that agroecology can offer agriculture to become more sustainable and regenerative. Agroecology is defined as a scientific approach to agriculture that builds on the resource-conserving aspects of traditional, local, and small-scale farming, while drawing on modern ecological knowledge and methods (Gliessman 2015). Main emphasis is given to the study of soil (management, fertility, erosion control and prevention, soil-borne diseases, pest suppressiveness) and water, to maintain diverse and productive plant and animal communities (Borsari 2020). Livestock production is very important to produce protein-rich foods, and recycling animals'

waste (manure) supports more ecologically the fertility of soils (Altieri 1999). An integration of diverse and multiple farming activities fosters the biodiversity of agroecosystems (farms), while enhancing their overall resilience, to the vagaries of markets and environmental disturbances.

This and more alternative approaches to farming (e.g.: organic, permaculture, biodynamic, agroforestry), that are more ecologically-sound and conservative of the resources needed to grow food, have become of interest to an increasing number of farmers in Panama (Santamaria-Guerra and González-Dufau 2017). There is a pressing need to restore peoples' rights to produce their own food in Latin America (Altieri 1999), while remediating to social inequalities that a neoliberal economy has brought with it, in the name of progress and modernity, following the end of World War II. Although specific UN Sustainable Development Goals (e.g.: SDGs# 2, 3, 6, 12, 13, 15) intersect directly with agriculture, in this context, the author wanted to make persuasive the case that all 17 goals intertwine with farming, food security and production, to ensure adequate nutrition and sustainable living. Therefore, there is a need to introduce agroecology to more farming communities, while educating the larger population of professional agriculturists, students of agriculture, stakeholders, and consumers, to comprehend the benefits and opportunities that agroecology can bring to the food system in Panama, should this approach to farming get further traction.

1.1. The two Extreme Poles of Agriculture in Panama: Agribusiness and Subsistence Farming

The agribusiness concept was conceived by economists Ray Goldberg and John Davis of the Business School of Harvard University in the 1950s and they defined it as the sum of products, processes, technologies, and services that are used to maximize efficiency in farming, through vertical integration (Borsellino 2019). Agribusiness is designed to serve agro-industrial systems, encompassing companies and multitudes of their workers, who are engaged in a variety of production and service roles, within the food system. These range, for example, from meat packing to fruit and vegetable processing, from the management of supermarkets, to supplying fast-food restaurants and overall, to fulfill and maintain the needs and the distribution flow of a highly centralized food system. In the U.S., agribusiness worked tirelessly since the 1950s to remove monopoly constraints, while deregulating health and safety standards to protect the interests of corporate, American agriculture, while increasing its competitiveness on a global scale (Engdahl 2007). According to Rosset (2000), the World Trade Organization (WTO) was established to achieve these goals and its power was amplified by free trade agreements that apparently promised food abundance and security, when realistically, these stripped the livelihood of millions of farmers worldwide, to maximize the financial gains of agribusiness and to show the path to follow toward success in agriculture.

Panama together with most countries in Latin America has not been immune to the narrative predicated by agribusiness and its claims about modernizing agriculture for generating wealth and improving food access and quality of life. However, it never made clear that a conversion of local food systems to agribusiness would have enriched only corporations and their executives, at the sacrifice of land conversion into monoculture, countryside depopulation, massive use of agrichemicals causing pollution, loss of soil and biodiversity (Borsari et al. 2014b). Another tangible consequence of agribusiness consisted in debilitating food security in countries that were lured into this and similar, entrepreneurial ventures, as demonstrated by an increasing poverty, malnutrition, dependence on food imports from abroad and loss of germplasm (Borsari 2011).

The World Bank, the International Monetary Fund and the World Trade Organization reduced, or even eliminated tariffs and other constraints in favor of an unlimited import of foods via international trade agreements, such as GATT and NAFTA (Bello et al., 1999). However, this apparently benign approach to food trade and distribution proved to be detrimental to the economy of most developing countries because it overwhelmed their markets with foods coming from abroad, that was sold at prices below the local production costs. Consequently, local family farmers lost their land because low crop prices did not allow the economic survival of small farms, causing a concentration and ownership of

agricultural land by few, larger farmers (Rosset 2000). A reduction in the number of farms came at the expense of environmental deterioration, soil erosion and pollution, caused by an intensive use of agrichemicals, to protect monocultures of genetically engineered (GE) crops (Borsari et al. 2014b).

On the opposite pole of the agriculture spectrum is subsistence farming, which occurs with the primary goal of growing food to meet the needs of farmers and their families. Although considered primitive and inefficient by agribusiness standards, this type of agriculture produces the 70% of foods, worldwide, while consuming only the 3% of the energy, when compared to the 30% needed by conventional, industrial farming (Altieri et al. 2012). Previous estimations about the productivity of agroecology by Altieri and Toledo (2011) suggested that global food production could increase 50% of present agricultural outputs if farming would convert to agroecological methods and practices.

In the meantime, jobs in production agriculture continue to be lost as machines, computer networks and automation systems replace human labor and draft animals. Rural communities disappear from the agrarian landscape as farmers and farm workers migrate to cities in search of better living conditions, while attempting to recover from their lost livelihoods. Natural resources like soil and water sources deteriorate quickly, as nobody is left to care about them. Huge swaths of land are purchased by foreign investors and corporations, that without remorse, will sacrifice biological richness and diversity to convert vast territories into a homogeneous landscape, grown with a single crop to maximize their lucrative gains and competitiveness, in the global market. Foley and his collaborators (2011) calculated that such a fast-agricultural intensification is responsible for having converted about 39% of terrestrial ecosystems and that these shifts have been occurring at a scale that has been acting as a gigantic force, changing permanently, the physical geography of planet Earth.

Paradoxically, food security is jeopardized through the agribusiness model because domestic food production falls in the face of cheap imports, whereas land that was once used to grow food becomes a further extension of the industrial agriculture behemoth, whose outputs are not even used much as food, but rather as feed for livestock species raised in Confined Animal Farming Operations (CAFOs), or as biofuels. Agribusiness remains highly consumptive of resources, extractive and thus, dissipative whereas subsistence farming is self-reliant of traditional knowledge and conservative of resource use for growing food (Fig. 2).

FIG 2
Antipodal paradigms of agriculture in Panama

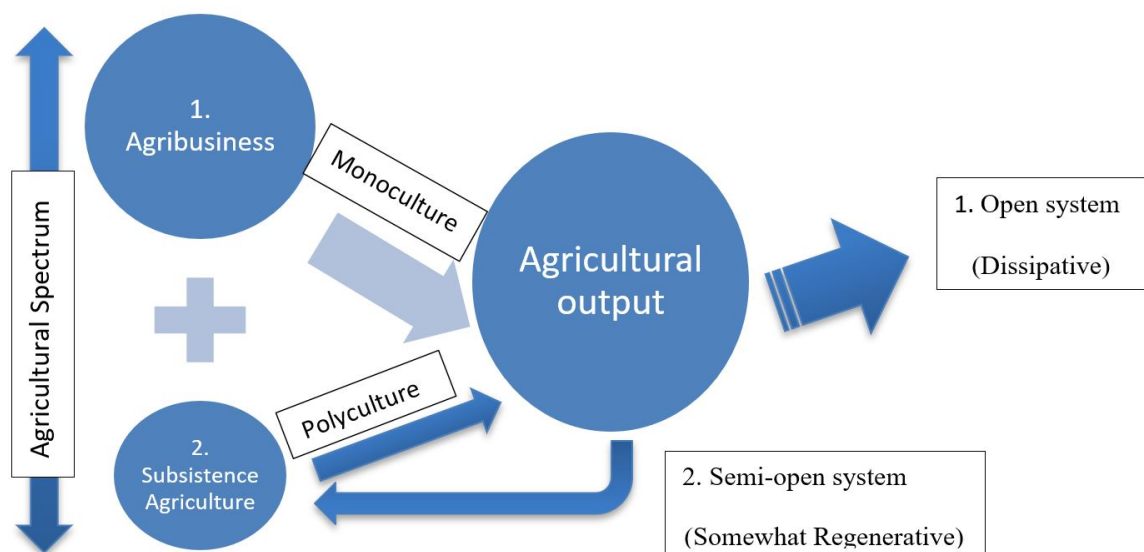


Fig 2. Antipodal paradigms of agriculture in Panama.

2. METHOD

This work employed a qualitative methodology to study what emphasis is given to agroecology in Panama's agricultural panorama, while verifying its potential and feasibility to ensure food security for its growing population. Qualitative data derived from a document analysis review of works dealing with agriculture in Panama and curricula in the agricultural sciences. Interviews were conducted with a sample of 21 agricultural stakeholders between September 2019 and March 2020.

2.1. Documents Review

The documents review component of this study consisted in a thorough analysis of the current literature, which included the web sites of farming associations, agricultural companies, the Department of Agriculture (MIDA) and agricultural research organizations (IDIAP). Also, curricula in agriculture in place at Universities in Panama were considered to understand the structure and content of study programs in the agricultural sciences. This effort served to substantiate the preparedness of agriculture professionals in understanding the value of alternative forms of food production that are ecologically sound, less energy demanding and potentially, regenerative.

2.2. The Interview Participants

The interviewees of this study were a snowballs sample (n=21) of professionals (men and women) who are engaged in food production in various capacities. It consisted of 14 men and 7 women. These, except for 6 farmers (3 men and 3 women), were all college educated, agriculture professionals (farmers, professors, researchers), who earned their degree/s in agriculture from universities in Panama, or abroad (Table 1).

Table 1 Classification of interview participants

TABLE 1
Classification of interview participants

	Male	Female	Affiliation	Province	Subjects
Farmer	5	4	Ganadería Castillo, La gordita Farm, Casiciaco Haren-Alde, Finca Flores, Castro & Family Farm, BFI - Estupa, Comarca Ngäbe-Bugle, Serracin Coffee Farm	Los Santos Herrera Chiriquí	2 3 4
Professor	4	2	St. Mary University La Antigua (USMA) Oeima Technological University (OTU) University of Panama (UP)	Herrera Chiriquí Chiriquí	2 2 2
Researcher	5	1	Agriculture Research Institute (IDIAP)	Panama	6

Two farmers (men) from Chiriquí were indigenous (Ngäbe) and farmed with their families on the land the government set aside for them (Comarca Ngäbe-Bugle), in the north of Chiriquí province.

2.3. Interviews Protocol

The interview method can be a valid research tool when qualitative researchers work with human subjects (Glesne 2010). However, attention to potential biases should be kept in mind by researchers to avoid threats to the trustworthiness of their studies (Patton 2014).

The interviews were conducted through Skype, Facebook, or by phone, to accommodate at best respondents' daily schedules, and Spanish was the language used. The investigator identified four areas of concern for the interview portion of this study, being agroecology important for food security and thus, relevant to study how this alternative approach to farming is employed in Panama. These concerns stated in question format with additional probes for clarification, or amplification of the interviewees' thoughts were as follows:

- What is your personal definition of agroecology? Where did you learn about it?
- What are the opportunities for moving food production towards agroecology in Panama? Who is leading the effort?
- What are the challenges for moving food production towards agroecology in Panama? What are the main barriers in your opinion and how could these be overcome?

— How much emphasis does agroecology play in the education of future agriculture professionals in Panama?

In order to eliminate any possible bias, the investigator tried to understand only the respondents' epistemologies, without advocating a personal agenda, but rather establishing a trusty relationship with each respondent. The investigator made every attempt to maintain a neutral stance in asking the questions and responding to any concerns, or questions that interviewees might have had. The absence of any possible interpretation of non-verbal cues that might have been apparent in personal interviews, further reduced any aspect of investigator bias. The protection of human subjects was ensured through approval by the Institutional Review Board (IRB) of Winona State University.

3. RESULTS: INTERVIEWS DATA

The interviewees (initially two) were solicited to participate in this study in September 2019 and it was at the end of their interview that they were asked to suggest the names of more respondents. Thus, a total of 32 subjects were identified in early October. Of these, 19 accepted to be interviewed.

Each interview lasted about 30 minutes and these meetings were scheduled at the wish of the respondents, through a preliminary phone call, or e-mail message. Interviewees were informed about the nature of the study, its purpose, and needs. Also, they were assured that their anonymity was protected and that they could have withdrawn without penalty from the interview at any moment if they did not feel comfortable. Finally, they were asked permission to have their answers recorded.

The answer to the first question (What is your personal definition of agroecology? Where did you learn about it?) was diverse among respondents. Most farmers could not give a definition of this concept and said they ignored this concept, whereas two of these from Chiriquí said: "agroecology is farming while protecting or restoring natural patches within the farm" and "agroecology is a restorative agriculture that aims at conserving wildlife and biodiversity". These responders were men. One of these learned about agroecology from a story in a free, monthly publication called: *Ecos del Agro*, whereas the second one was first exposed to this concept at a conference presentation in David, in 2017. All the professors defined agroecology as the merging of agronomy and ecology to achieve crop yields without exhausting the natural resource base of farms. Only three of these (one man and two women from Chiriquí) indicated that they learned agroecology while in pursuit of their graduate degrees, abroad (Germany, Argentina, and the US). One female professor added that: "We begin to hear more about agroecology in Panama (especially within professional circles), but in my opinion, the way of farming has not changed much since the introduction of chemicals in the 1970s". Similarly, all researchers defined agroecology and most of them were introduced to this approach to agriculture from presentations, workshops and seminars that had been held in Panama in the last 6-8 years. One researcher (man) from Los Santos said: "My exposure to agroecology was through studies in entomology and pest management when I worked for my Ph.D. at the university of Montpellier in France, in the early 2000s".

For the second question (What are the opportunities for moving food production towards agroecology in Panama? Who is leading the effort?) the following responses were generated. One female farmer from Herrera said: "We cannot afford the improved seeds, fertilizers and other inputs available on the market therefore, our products are organic. The food from our 2 ha. farm provides barely to support our family of six. If we have some extra produce, then I sell this to our two grocery stores, in Las Minas". One farmer from Chiriquí pointed out that "Coffee is a major crop in Panama, serving the national and international market. Agroecology provides opportunities to enhance the sustainability of coffee production and agroforestry is the agroecological practice on my farm to protect biodiversity and regenerate soil fertility. The association of coffee producers in Chiriquí is leading the effort of developing interesting market niches that include agritourism with a focus on the whole coffee production chain". Six of the nine farmers (men and women,

including the two indigenous growers), pointed out that their knowledge of farming derived from the learning they received from their parents and grandparents. Among these, one woman from Los Santos added: “I have been taught to grow food without using the many inputs that are deemed necessary to farm today, without knowing what agroecology is. Nonetheless, I rotate crops, save seed, and make compost to feed the land! Now there are groups of farmers that have become interested in organic agriculture because they can produce crops without spraying toxic chemicals. I think this is a clean form of agriculture like agroecology. Am I right?”. One farmer (man) from Chiriquí emphasized on agritourism as an interesting venue that amplified his interest in agroecology, adding that: “At my farm we are protecting native animal species by leaving uncultivated strips of land within the crop fields and these ecological corridors attract tourists who wish to see endemic wildlife. I envision agroecology and agri/ecotourism becoming enlaced more strongly for the economic potential and benefits these could bring to our province (Chiriquí) and to the rest of Panama”. One professor (man) from Saint Mary University La Antigua (USMA) said: “Our country is biologically diverse and this diversity benefits agriculture in many ways. It is important to demonstrate and educate growers about production methods that preserve biodiversity and resources”. Both professors from the University of Panama (UP) gave a similar answer adding that: “ecotourism is beginning to attract many foreign tourists every year. Therefore, agroecology is a strong allied field for improving both agriculture and conservation in Panama”. One of these added that: “Conservation International in Panama is the organization leading the effort to inspire farmers to understand the value of biodiversity in agriculture”, whereas the second one mentioned a group of private landowners in Chiriquí as the association leader in stewardship and conservation in this province. Two professors from Oteima Technological University (OTU), one from USMA and one from UP indicated that silvopasture is becoming the approach adopted by many ranchers in Panama that they would consider agroecological. One of these added: “Our traditional live fences (cercas vivas) are being added with trees within the pasture, as the association, cattle-trees-fodder crops functions much better to increase the health and productivity of the animals”. The professor from USMA mentioned the Azuero Ecological Project in Pedasí as the leading NGO in Los Santos, fostering silvopasture and reforestation with native tree species in this very dry region of the country. All six researchers of the Agriculture Research Institute (IDIAP) attributed the benefits of agroecology to improved quality of life for producers, consumers and success in crop protections, animal health, soil, water, and biodiversity conservation. One respondent (woman) added that: “IDIAP is the officially recognized institution in Panama whose research in agriculture aims at sharing knowledge and technologies with all farmers”. Three researchers mentioned the Latin American Society of Agroecology (SOCLA) to which Panama belongs, as the international leader that is moving agroecology forward, in the southern part of the western hemisphere.

The third question asked the subjects about challenges and barriers for moving food production towards agroecology in Panama and suggestions for removing possible constraints. There was a consensus among farmers about the sense of isolation and detachment from governmental institutions like the Ministry of Agriculture (MIDA) in Panama-city. Seven farmers, (three men and four women), pointed out that small producers struggle more and more to survive. Drier seasons due to climate change affect crop yields and livestock survival, while poverty and malnutrition are expanding in rural communities. Two farmers (men) from Chiriquí added that they had to invest a significant amount of money in the last ten years to install irrigation infrastructures on their farms to cope with the unpredictability of rain precipitations. Four professors from universities in Chiriquí indicated that micro-irrigation systems have become very popular in farms and orchards of their province if farmers can afford this technology. One added that: “at OTU a hands-on course in hydroponics has become quite popular among students and local vegetable growers, also to improve quality of the produce. Financial resources lack however, including monetary incentives from the government”. Researchers offered similar answers to those provided by the professors however, three of them added that research endeavors at IDIAP experimental farms are supported by the funds coming from the Ministry of Agriculture (MIDA) yet, these projects often produce knowledge that is not applicable to most

subsistence and indigenous farmers. One researcher added that: “our ability to be published in international journals remains limited and I think this is an additional, important barrier to an expansion of agroecology at this moment in Panama. I cherish grant opportunities for sending agricultural researchers to study abroad in pursuit of a doctorate, as more Ph.Ds in IDIAP and other governmental organizations will contribute to a more international exchange of ideas, innovations and approaches in favor of agroecology”.

The fourth and final question asked the subjects about how much emphasis does agroecology play in the education of future agriculture professionals in Panama. None of the respondents had been exposed to agroecology while being educated in Panama however, farmers felt they had been practicing it already, without having acquired formal knowledge in agroecology. One professor at UP said: “Our curricula in agriculture remain structured as they were first introduced with the influence of study programs in place in universities in the US. Therefore, they have been focusing on a high level of specialization that begins already since the second year of undergraduate studies”. Three professors (one each from the three universities considered in this study) indicated that students’ exposure to farm work/hands-on activities through internships, practicums, or service-learning courses offer the best exposure to reflect about farms as complex systems yet, this concept may not be investigated any further”. One professor at OTU argued that the agriculture curriculum offers a 3 credits agroecology course however, he did not know exactly what was taught in this class. One professor from USMA said: “We women professionals in agriculture begin to see food production through agroecology also as a movement for emancipation and liberation from a domain that historically, has been dominated by men”. All researchers were consensual in asserting that all students should be exposed to agroecology early in their education and without having to go study abroad to learn about it. Along this thread, one researcher added that: “Highly respected cultural exchange programs like Fulbright for example should facilitate the process of curriculum development and change and I wish that Panama could host scholar agroecologists to assist with the evolution of agricultural education in our country”. Three researchers advocated for an education reform that could start in primary education to give all children basic knowledge of food systems, ecology and natural resource management adapted to specific levels of instruction. One of these researchers added that: “this is the kind of education we need in Panama, to fulfil the 17 SDGs, goals set by the United Nations to achieve a sustainable development”.

Agroecology is a regenerative approach to food production, which relies also from the ecological services provided by biodiversity (Gliessman 2015). The integration of ecotourism in conjunction with an establishment of agroecology in Panama is a benign endeavor which, emerged from the interviews data as an important aspect for offering opportunities that complement mutualistically, agriculture and tourism. Borsari and team (2021) verified this claim, while substantiating that diverse and multifunctional farms, or agroecosystems, are vital for enhancing their resilience and a culture for conservation in Panama. Also, traditional, peasant farming is a valuable resource for agroecology because it is enriched by knowledge of methods and practices that assist agroecologists to answer complex questions about the management of farming systems and how these can be veered toward sustainability (Rosset 2000; Altieri and Toledo 2011).

3.1 Results: Document Analysis

The qualitative data obtained from the document analysis review indicated that a plethora of information about agroecology is already available in the literature, substantiating the benefits that it can provide to farming communities and their environment, in Latin America (Altieri et al. 2012; Gliessman 2015; Ferguson and Morales 2010; Simon et al. 2020) and other world regions (Wezel et al. 2009; Paoletti et al. 2011; Vandermeer et al. 2018; van Zonneveld et al. 2020). Initial interests in organic farming as a more ecological way of producing food emerged in Panama more than 20 years ago, spurred by a growing demand for quality foods by the community of retirees from north America, who reside in the capital and other major cities of the country (Hernández 1998). Few studies that were carried out in Panama in more recent times, suggested agroforestry as a sustainable approach to agriculture (Fischer and Vasseur 2000), pointing out the need of forests conservation to mitigate climate change (Jiménez et al. 2018) and biodiversity preservation

(Camargo Buitrago et al. 2016), as imperative strategies to ensure sustainability in agriculture. However, the first publication mentioning agroecology as a viable method to counteract the unpredictable weather patterns caused by global climate change in Panama, was published only a few years ago (Borsari et al. 2014a). It was followed by a review study conducted in farms of Chiriquí province, the following year (Santamaría and González 2015). Zachrisson and his collaborators (2017) reiterated the economic relevance that this province possesses for agriculture in Panama, describing also the environmental changes occurring to the landscape due to population growth.

Despite these records from the literature however, agroecology remains challenged to get traction. The reasons are multifaceted, and the author conceded that this reluctance could be rooted also in the structure of curricula in agriculture. The review of study programs for undergraduate students from the web sites of two private institutions (USMA in Herrera and OTU in Chiriquí) and the national, public university (UP), showed that undergraduate curricula in agriculture focus on specializing students in a specific sector of the agroindustry. For example, OTU (<https://www.oteima.ac.pa/programas/licenciaturas/licenciatura-en-administracion-agropecuaria/>) offers an emphasis in agricultural administration, whereas USMA-Azuero (<https://www.facebook.com/usmaazuero>) has its curriculum with a focus in animal science. Instead, the University of Panama (<https://facagropecuaria.up.ac.pa/>), offers a variety of curricula in agriculture (undergraduate and graduate) with emphases in many more agricultural sectors (Cordero Clark 1996). Such a rigid structure of curricula in the agricultural sciences in Panama might have derived from the influence of agriculture education of US Land-grant universities. A gap between farming and sustainability was interpreted as a limited, or nonexistent exposure to ecology by Borsari and Vidrine (2005), when evaluating agriculture curricula from a sample of universities in France, Italy and in the southeastern region of the US. In more recent times instead, agroecology has been transforming education in agriculture in Scandinavian countries and in the upper Midwest region of the US. Its employment inspired educators to adapt agricultural curricula to fulfil the need of connecting food production with natural resources and more related ethical and social themes, that had always been excluded from the education of agriculturists (Francis et al. 2011).

The websites Agroecology in Action (<http://agroeco.org/>) and ATTRA Sustainable Agriculture Program (<https://attra.ncat.org/>), continue to be valuable resources to learn about agroecology and its applications to food production, in diverse environments, including urban settings (Altieri and Nicholls 2018). Also, the Latin American Society of Agroecology (SOCLA) was another important resource that was consulted for this study (<https://www.soclaglobal.com/>). This website is rich with technical information to divulge agroecology principles across countries in meso and south America. Also, La Via Campesina (<https://viacampesina.org/en/>) is a notable network of a peasants' movement interested in food justice, sovereignty, and security around the world, continuing to serve agroecology from the socio-cultural aspects of peasant agriculture and rural communities living. Selected information from these websites was seminal to educate students of agriculture and faculty at a private university in Panama, about agroecology, where this effort led also to the development of an experiential curriculum of workshops that was offered in 2015 to subsistence farmers of Herrera province with success (Borsari et al. 2016). On a similar trajectory, a distinctive program improved food security and nutrition among the most vulnerable communities of indigenous people, who live in the reservation (Comarca Ngäbe-Buglé), in the western region of the country (González Dufau et al. 2019).

4 CONCLUSION & RECOMMENDATIONS

Transitioning from industrial agriculture/agribusiness to agroecology is possible yet, this effort remains a complex issue for Panama, which is not free of obstacles. Major barriers for this shift to occur are economic and political, intertwined together by an unconditional governmental support, that continues to welcome

foreign investments and corporative expansions, without many concerns about losing family farms. A review study by Santamaría Guerra and González Dufau (2015) suggested that there is a growing movement toward ecological agriculture in Panama, which is getting traction among farmers to counteract increasing food insecurity trends, that were amplified in recent years by heavy reliance on food imports from abroad. Subsistence farmers and indigenous people are most vulnerable to food insecurity because they grow their food on small parcels of marginal land, which ranges between 0.5 to 1.5 ha., and that often is even unsuitable for farming (González Dufau et al. 2019). For several decades, an intensification of agriculture caused various forms of environmental degradation and uncontrolled deforestation in Panama (Heckadon-Moreno and Espinoza-González 1985), have been affecting more and more, protected reserves and encroached into indigenous lands. Thus, water contamination and other hydrological impacts caused by expanding monocultures that replaced forests, have become inevitable consequences of ecological disturbances that remain compelling challenges, for transitioning agriculture toward agroecology.

Commendable efforts for developing a more sustainable agriculture began in the late 1990s in Panama, when groups of vegetable farmers in the provinces of Chiriquí and Coclé established growers' associations and converted their farms to organic production (Hernández 1998). Nonetheless, a lot of work still needs to be done for keeping 'momentum' with this and similar initiatives of cooperation and associationism in agriculture. It remains notable to mention that agroecology in Panama was contemplated recently, among priority goals for research and innovation in agriculture to be pursued by 2030 (Santamaría Guerra et al. 2016).

Complexity remains a keystone attribute of agriculture worldwide and its alternative models are not free from limitations, nor paradoxes (Onwueme et al. 2008). The linear approaches predicated by agribusiness, aiming primarily at improving efficiency and productivity are simplistic and illusory for an achievement of sustainability in food systems (Borsari et al. 2014b). Complex systems demand multidisciplinary approaches and competences in systems thinking by stakeholders and these can generate only proximate solutions to the problems created by agriculture. Agroecosystems are complex because these are living systems and as such, they change and adapt through evolution. Anthropogenic changes are their intrinsic components that expand their complexity a step further. Farms that have already transitioned to an agroecological management and practices, have emerged from the scarred agricultural landscapes of Panama as tangible examples of resilience, capable of satisfying the needs for food in rural communities (Santamaría Guerra and González Dufau 2015). Their design and management could be easily transferred across its provinces. Also, the Covid-19 pandemic of 2020 has clearly shown major dysfunctions within the food system in Panama, through widening inequities among workers along its supply chain. This is suggesting that the current agro-industrial model of food production is inadequate to maintain people's health and food security, as centralized food processing plants have exacerbated this public health crisis (Wallace et al. 2020). Christensen et al. (2020) argued that these and similar facilities are the weakest link in a vulnerable supply chain, which dominated by few, vertically integrated corporations continue to threaten access to healthy, nutritious food to many citizens in every country. Yet, agribusiness continues to maintain political power in controlling markets, while supporting a highly centralized food system in which many farmers continue to remain entrapped. International, trade agreement policies like NAFTA have spurred inequities and abuses that threaten farmers' independence and the survival of local food processing facilities (Christensen et al. 2020). Similar policies that disregard an enforcement of anti-trust laws and food labeling for traceability purposes remain detrimental to the credibility of food systems' safety within the public and potentially, could damage consumers' health (Rohr et al. 2019).

In sum, the agri-food supply chain needs to be structurally transformed and Panama is not exempted from this compelling need. An emphasis on decentralization, especially when processing and marketing meats and other animal/dairy products, should be a priority goal to achieve, in averting the spreading of notorious zoonoses (Wallace et al. 2020). This will require support and investments not only to preserve

the functionality of existing farms, but also to provide incentives for new farmers to produce quality food according to the tenets of agroecology theory and practices (Altieri 2016). Thus, a shift in this direction will bring multiple benefits to the people of Panama, their food system and environment, and these include:

- Enhancing transparency and traceability of food products at every level of the supply chain, from producers to consumers.
- Restoring the food system to a scale of production that recognizes the needs of conserving the natural resource base of the environment and fosters a strong sense of stewardship among farmers.
- Reducing food waste along the supply chain while enhancing recycling at every step of the production-consumption pathway.
- Recognizing the multifunctionality of agriculture to develop further market niches (e.g.: ecotourism, agritourisms, value added products), that brings multitudes of foreigner visitors to Panama each year, to experience its nature, and abundant diversity (cultural and biological).
- Introducing agroecology courses at various levels of instruction across grade schools and universities.
- Providing more educational opportunities in agroecology through field-days at farms, where farmers may share their knowledge and experience among themselves and the larger community.
- Conserving traditional farming knowledge as a sound resource in research and learning agroecology, to complete the preparedness of the next generation of professionals in agriculture.

These recommendations may be arduous to achieve in a country with limited financial resources and modest infrastructure yet, knowledge can make a difference in maintaining momentum with the transition process here proposed. This knowledge derives from many sources such as: present scientific endeavors, associated technologies and peasant epistemologies from which agroecology is connected to (Altieri 1999; Altieri et al 2012; Borsari et al 2016). The preparedness of professionals and leaders in agriculture will be pivotal in strengthening an establishment of agroecology in Panama, with possible extensions to neighboring countries. This will be achieved with education reform, leading to curriculum adaptations and improvement converging toward sustainability in agriculture (Borsari and Vidrine 2005) and food systems. These recommendations are suggested as a most meaningful invitation and auspice to scale up a transition from agribusiness toward agroecology, in Panama.

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