



Empowering Women and Building Sustainable Food Systems: A Case Study of Cuba's Local Agricultural Innovation Project

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This paper presents a case study of Cuba's Local Agricultural Innovation Project (PIAL for its initials in Spanish), with a focus on its gender-specific elements. The PIAL methodology was first introduced in Cuba in the early 2000's as a means of carrying out participatory plant-breeding to facilitate the development and use of locally-adapted seed varieties and help farmers diversify their production. A cornerstone of Cuba's transition toward more agroecological production, PIAL currently operates in 75 municipalities across 12 provinces and in the Isle of Youth special municipality, and the model has evolved from its initial focus on participatory plant-breeding to include more holistic programming aimed at increasing food system sustainability and community resilience. In this paper we highlight how the gender-specific aspects of the PIAL model facilitate female participation and leadership and how this contributes to positive economic, ecological and sociocultural changes in farming households and communities. Key impacts include: increased inclusion of women in developing and implementing farm innovations; increased self-confidence for female farmers and farm-family members; increased productive diversification on family farms; and, increased employment and household income through women-led micro-industry projects and facilitation of commercialization opportunities. As we elaborate on these impacts of the PIAL work, we also explore broader themes with respect to how the model has evolved over time, factors for success, and vision toward the future. We discuss the ways in which PIAL's gender work is contributing to a revival and revaluing of *campesina* culture, how it is challenging deeply entrenched norms of both femininities and masculinities, how it is engaging youth and fostering inter-generational knowledge-sharing, the ways in which it leverages the expertise and resources of formal research institutes to support

locally-focused participatory initiatives and, finally, how it is building networks and partnerships that embed its work in institutional (e.g., government) settings at a variety of scales, thus helping to ensure use of local government funds for the work, and guaranteeing longevity independent of external funding.

Keywords: agroecology, women's empowerment and gender equality, community development, participation and inclusion, Cuba, agrobiodiversity conservation

“What does it mean to be a farmer?” I asked the women, and they responded in more than 10 different languages. Some women laughed, some of them wept. And others weren't sure where to begin because no one had bothered to ask them the question before.

(Moyles, 2018), p. XXVI

“The myth of the weaker sex has been shattered by the reality of women who have not hesitated to occupy the trenches with men, who have spared no effort in each of the tasks undertaken by our [Cuban] people along the complex road of our development.”

Vilma Espín, Cuban Revolutionary and politician.

INTRODUCTION

Cuba is a well-known and oft-cited example of a nation that has, over the past two decades, made significant strides toward developing more sustainable food systems. The foundation for this reputation has been Cuba's so-called “agroecological revolution,” which began in earnest in the early 1990's when the fall of the Soviet Bloc precipitated a sudden loss in the largely subsidized, imported inputs necessary for industrial farming on the island. With imported resources scarce and a related food security crisis, Cuba embarked upon a nation-wide project to transition its agricultural sector toward an agroecological model that would be more knowledge-intensive and less export-oriented, drawing on traditional farmer knowledge as well-expertise in Cuba's scientific community. Facilitated by state policy, research and development, and mobilization of farmers and their organizations, core pillars of this transition have included: land reforms to increase access for people willing to engage in agriculture; diversification of production (e.g., away from monoculture sugarcane); large-scale implementation of urban agriculture projects across the country; market reforms to increase opportunities for producers to sell their goods; and research and knowledge mobilization campaigns focused on developing and sharing agroecological innovations [see Funes (2016), Fernández et al. (2018a), and Funes et al. (2002)].

Speaking to the international relevance of Cuba's agricultural transition, Fernández et al. (2018a, p. 3) argue that “agroecology, as practiced, explored, and adapted by Cubans, serves as a mode of surviving the crises wrought by industrial agriculture—in both its capitalist and communist forms.” Indeed, Cuban knowledge and experience play an important role in global and regional conversations regarding how to support agroecological

development, Cuban agroecologists serve as prominent members of agroecological networks in Latin America and beyond, and Cuban organizations such as the National Association of Small Farmers (ANAP, for its initials in Spanish) are renowned for their work to promote agroecology on the national and international stage [see Funes et al. (2002), Rosset and Altieri (2017), and Fernández et al. (2018b)]. One specific program that has received particularly significant international attention for its role in Cuba's agroecological transition has been ANAP's *campesino-a-campesino* (or farmer-to-farmer) program, which is founded upon the principles of social learning and has been credited for contributing to the rapid spread of agroecology across the island (Álvarez, 2002; Rosset et al., 2011; Martínez-Torres and Rosset, 2014; Funes, 2016). Another program that has been less widely discussed in English language publications, but is similarly grounded in social learning and participatory development processes and has also been integral to Cuban agroecological development, is the *Proyecto de Innovación Agropecuaria Local* (Local Agricultural Innovation Project, or PIAL). The PIAL approach was officially introduced in Cuba in 2001 and built upon a participatory plant-breeding initiative that had begun 2 years earlier, drawing heavily on experiences from elsewhere in Latin America, particularly Nicaragua, El Salvador, Bolivia and Honduras, where such programs had been implemented in the early 1990's and were experiencing some success (Ashby et al., 2000; Braun et al., 2000).

From its inception, the PIAL approach included some explicit recognition of gender issues, for example ensuring that women were included in the selection processes for preferred seed varieties. However, in the project's early days women were under-represented and, as a result, their preferred criteria for seed selection—which often differed from those of their male counterparts—were not given due consideration. Acknowledging this problem, the PIAL coordinating team decided to mainstream gender across project activities. This began with a pilot project but has since become an increasingly central component of the PIAL approach, with a national coordinator responsible for gender, specific gender strategies developed for each new phase of the work, and a multitude of activities that focus on promoting social equity. With this new focus, PIAL is building rural women's capacity to engage in agricultural innovation and leadership and reshaping gender dynamics within farming households and communities. In so doing, the work supports a transition toward more sustainable, equitable, agroecological food systems.

This paper offers an in-depth examination of the PIAL methodology, with a focus on its gender-specific efforts and

their impacts. We argue that PIAL represents a promising framework for supporting transition toward agroecological food systems that support gender equity, along with ecological regeneration and community development. Our paper begins with a discussion of the relationship between agroecological knowledge and innovation, gender, and development. We then provide some background to Cuba's PIAL methodology and describe the key elements of its gender-based work. Following this description, we outline the methods used to collect the data presented in the paper. Our results demonstrate the various ways in which the PIAL methodology has contributed to local economic development in rural communities, to supporting agroecological development in Cuba, and to processes of social change at various scales. We build upon these three categories of results to discuss how PIAL is contributing more broadly to a revival and revaluing of *campesina* culture, and how it is furthering agroecology as a science, set of practices and social movement.

AGROECOLOGY, INNOVATION, GENDER, AND DEVELOPMENT

While understandings of agroecology are epistemologically plural and thus subject to some debate (Isaac et al., 2018), there is growing consensus that it is best conceptualized as three distinct, though interrelated, elements: a scientific discipline; a set of practices; and a social movement (Méndez et al., 2013; Gliessman, 2014; Levidow et al., 2014). As a discipline, agroecological research seeks to develop and systematize knowledge in an effort to better understand the socio-ecological relationships that characterize agroecological systems. A growing and rapidly changing field, this discipline has been critiqued for over-emphasizing western science models of knowledge production without sufficient inclusion of local, indigenous or traditional knowledges (Fernandez et al., 2013; Méndez et al., 2013; Snipstal, 2015; Pimbert, 2018). When viewed as a set of practices, agroecology draws much more directly upon locally-grounded empirical knowledge developed, held and shared by farmers across time and space (Altieri and Toledo, 2011; Méndez et al., 2013; Gliessman, 2014). As a social movement, agroecology is a more broadly transformative endeavor that is closely linked with the food sovereignty movement and includes an active political agenda to challenge power dynamics—including those rooted in gender—and push for structural food system change (Méndez et al., 2013; Rosset and Altieri, 2017; Pimbert, 2018). These three elements are not discrete entities, but rather are in constant dialogue with each other (Altieri and Toledo, 2011; Rosset et al., 2011; Méndez et al., 2013) as agroecology continues to gain traction as an effective pathway for building more sustainable agrifood systems (IPES-Food, 2016; Pimbert, 2018).

Indeed, in recent years agroecology has gained widespread international attention as a key mechanism for achieving the United Nations Sustainable Development Goals (SDGs) (FAO, 2019). Perhaps the most immediately obvious benefits of agroecology are ecological, as it restores and conserves natural

resources including soil, water and biodiversity (Gliessman, 2014; IPES-Food, 2016) and has been found to increase agroecosystem resilience to climate change (Holt-Giménez, 2002; Altieri et al., 2015). In addition, agroecological food systems offer socio-economic and cultural benefits, as they have been linked to increased food security (Altieri and Toledo, 2011; Altieri et al., 2012; Pimbert, 2018), rural poverty reduction and increased stability of farmer livelihoods (Altieri et al., 2012), and the maintenance of diverse cultural traditions (Altieri and Toledo, 2011; Pimbert, 2018). Given such findings, agroecology can be associated with a number of the SDGs, perhaps most notably eradicating poverty and hunger, increasing water-use efficiency, halting the loss of biodiversity, building climate resilience, promoting decent jobs and, as we will discuss in depth in this paper, achieving gender equality (FAO, 2019).

In light of this potential for agroecology to serve as a tool for sustainable development, proponents are paying significant attention to how agroecological knowledge and innovation can be most effectively generated, shared and applied in a global context characterized by “lock-ins” that favor industrial food production (IPES-Food, 2016). Notably, agroecology requires sophisticated knowledge of local ecologies and socio-cultural contexts and, as such, relies heavily upon local experiential knowledge held by farmers [see Warner (2007), Rosset et al. (2011), Altieri and Toledo (2011), Sumane et al. (2017), and Anderson et al. (2018)]. Innovation then must be conceptualized as “more than just the invention of new technologies or products; it entails processes where socially and environmentally sustainable ideas, technologies, products and practices emerge through stakeholder interaction... agroecological innovations should be people centered, meet smallholder and family farmers’ and consumers’ needs, be co-created, combine research and traditional knowledge, be locally adaptable, be based on open source data and technology, and enhance capacity for collective action and responsible investments” (FAO, 2019, p. xiv).

Defining innovation in such a way requires a shift away from conventional systems of agricultural extension, which tend to follow a top-down model wherein practices and products developed by institutions and industry are brought and taught to farmers (Blackstock et al., 2010). By contrast, agroecological knowledge-sharing relies far more heavily on processes of social learning, wherein farmers learn experientially with and from each other and others (Hassanein and Kloppenburg, 1995; Kroma, 2006; Warner, 2007; Schneider et al., 2009; Ingram, 2010; Singh et al., 2018). Such learning is, by definition, embedded within social networks and thus requires significant levels of social capital in order to be effective (Isaac et al., 2007; IPES-Food, 2016). While connectivity amongst like actors (e.g., farmers from a particular community or region) is important (Hassanein and Kloppenburg, 1995; Waters-Bayer et al., 2015), research suggests that connections amongst diverse actors (e.g., farmers from different regions, farmers and scientists) is particularly useful for the spread of innovative agroecological practices [see Humphries et al. (2015), Cadger et al. (2016)]. As Schneider et al. (2009, p. 476 italics added) explain, “[t]he

social learning approach represents a philosophy focusing on participatory processes of social change. This means integrating the knowledge of *different* people, whether they are farmers, scientists or experts...Changes emerge when actors 'change their minds' through critical thinking, interactions and dialogue with others."

Part of this recognition of difference requires that attention be paid to a range of oft-marginalized voices, rather than simply considering farmers as a unified category. As Cockburn (2015, p. 169) explains, "asking who is understood to have agricultural knowledge, and how this perception influences knowledge exchange, uncovers power imbalances in local, national and international relations, as well as along lines of gender and class, that remain barriers to exchange and collaboration..." For rural women in the Global South, a layering of these imbalances can severely inhibit their opportunities. In part, this is because women's agricultural knowledge and labor has, in many contexts, been systematically rendered invisible (Bezner Kerr, 2017; Schwendler and Thompson, 2017; Moyles, 2018; Bezner Kerr et al., 2019). Even as processes of development and social change have increased recognition of women in many ways, "social patterns persist and within agriculture the perception of farming as a male industry is hard to break..." (Bock and Shortall, 2017, p. 89). Despite making significant contributions to agricultural labor, a lack of social equality frequently results in women being left out of decision-making and control over agricultural resources, and they are often excluded from agricultural research and extension efforts (Bezner Kerr, 2017). Such exclusion mirrors trends for rural women to be marginalized in policy discourses and outcomes (Bezner Kerr, 2017), and unable to have their voices heard more generally in public life (Classen et al., 2008).

Exclusions such as these are explicitly recognized by SDG 5 (achieving gender equality), and there is increasing evidence that agroecology can and does promote such equality, valuing women's knowledge and participation in a way that challenges the gendered power imbalances characteristic of conventional agrifood systems [see Humphries et al. (2012), Rosset and Altieri (2017), Schwendler and Thompson (2017), Pimbert (2018), Bezner Kerr et al. (2019)]. For example, based on research conducted in Cuba, Rosset et al. (2011, p. 183–184) found that "[i]n the conventional system... 'the man was king,'" whereas in more diversified agroecological systems "a diversity of decision-making and income generating roles... work to reduce the weight of the patriarchy inside the family unit." Building upon this observation, a number of studies suggest linkages between agroecology and women's empowerment, as agroecological projects have enhanced women's capacity for social mobilization (Classen et al., 2008), increased their ability to make informed decisions to leave the house, take on leadership roles in the community and make agricultural decisions (Humphries et al., 2012), and gain access to agricultural resources, knowledge and extension (FAO, 2018). Results such as these suggest that attending to gender dynamics enhances the transformative power of agroecology (Bezner Kerr et al., 2019).

BACKGROUND AND OVERVIEW OF THE PIAL METHODOLOGY

Seeding the PIAL: Farmer-Led Research and Participatory Plant-Breeding

Drawing the ideas of agroecological innovation, participatory co-creation of knowledge, and social learning together, Altieri and Toledo (2011, p. 588) explain that "...agroecology emphasizes the capability of local communities to experiment, evaluate and scale-up innovations through farmer-to-farmer research and grassroots approaches." The concept of farmer-led research as a formalized methodology for fostering sustainable innovation began to gain traction in the early 1990's with the development of Farmer Field Schools in Asia and Local Committees for Agricultural Innovation (CIALs) in Latin America (Ashby et al., 2000; Braun et al., 2000). Guided by the principles of participatory research developed and advocated for by Chambers (1990, 1993) and others, the CIALs method aimed to facilitate farmers' ability to identify their own research problems, design and conduct on-farm research, and analyze and communicate results (Ashby et al., 2000). Initially, the focus was on developing improved crop varieties through a method that came to be known as participatory plant-breeding (PPB). Humphries et al. (2015, p. 3) describe the method: "...farmers organized in research teams were given the tools to plan and carry out randomized block design trials and replications, and to evaluate and analyze the results in a manner that was statistically verifiable...". The teams themselves consisted of local farmers who drove the research process; however, these teams were linked to research institutions "thereby increasing local capacity, not only to exert demand on the formal system but also to access potentially useful skills, information and research products" (Braun et al., 2000, p. 5). As such, the process fostered agroecological innovations co-created and shared through active social networks led by farmers but including a diversity of actors. By the end of the 1990's, there were ~250 CIALs active in eight countries across Latin America, with the majority located in Colombia and Honduras, and it was then that the Cubans began to look at implementing and adapting the approach.

The initial motivation for employing the PPB method in Cuba was closely tied to the crisis provoked by the fall of the Soviet Bloc and the accompanying large-scale transition of the country's agri-food sector. With severely limited resources to fertilize and irrigate crops, researchers at the National Institute of Agricultural Sciences (INCA, for its initials in Spanish) noticed that a collection of heirloom corn varieties planted on their experimental farm were thriving, and they invited local farmers to select their preferred varieties and plant them on their own land. This process, wherein a diversity of seeds from one particular crop would be planted, farmers would be invited to select their preferred varieties based upon their priorities, and would then take the selected seeds for planting on their farms became known as a *Feria de Diversidad*, or Diversity Fair (Ríos-Labrada, 2013). These fairs became—and to a great extent remain—the central pillar of the PIAL approach (Ortiz Pérez, 2013). Following the first fairs, it became clear that farmers

themselves were taking the varieties, sharing them with others, experimenting on their own farms, and applying the approach to a wide range of crops, acting in close collaboration with scientific institutions like INCA to produce and replicate agricultural innovation (Ríos-Labrada, 2013). This process has today been converted into a widely implemented good practice across Cuba.

Consolidating and Growing the PIAL

Following widespread success of and recognition for the PPB methodology as employed in Cuba, it was decided that the Diversity Fair approach could be extended beyond seeds to include a range of agricultural technologies, thus fostering a wider array of innovations (Ríos-Labrada, 2013). This expanded version of farmer-led research became the *Programa de Innovación Agraria Local* (PIAL), or Local Agricultural Innovation Program. Since its inception in 2001, the program has been based out of INCA, with collaboration from a number of other Cuban institutions, including universities and ANAP. It has also received funding and support from a number of international agencies such as the Canadian International Development Agency, USC Canada, the Swiss Agency for Cooperation and Development (COSUDE) and the German NGO Welthungerhilfe (AAA, for its initials in Spanish).

The construction of PIAL was grounded in the principles of participation, collective leadership and dialogue of knowledges. Peoples' available capacities (knowledges, experiences, and resources) are drawn upon and strengthened through an action learning process wherein sustainable changes are made. The management of a development challenge can be facilitated through cycles of learning in action, in which facilitators intervene. These cycles vary depending on the demand for development, the context that directs it, and the participatory action research methods that are promoted. They can include or combine the linear transfer of knowledge, forums for the collective construction of knowledge, exchanges, peasant, participatory, and conventional experimentation. The work draws upon the Action Learning method [see Revans (1998)], wherein participants learn from their own experience in exchange with others, discover a challenge and propose alternatives and engage in cycles of planning, execution and reflection. In this process, a catalyst team facilitates each learning cycle based upon the challenges identified. The catalysts can either be municipal or provincial and influence institutions and productive chains (Ortiz et al., 2015).

The goals of the PIAL at its inception were “to revitalize the [Cuban] agricultural sector through increased participation of small-scale producers in food production and environmental protection...” [and] to strengthen the resilience of the food system through inter- and intra-species crop diversification (Teshome, 2013, p. 15, translated from the original Spanish). In the first phase of the methodology's development (2001–2006), the focus was quite heavily on expanding the use of Diversity Fairs across the country, particularly those focused on seed varieties. The second phase of the PIAL (2007–2012) represented a more concerted effort to expand beyond PPB and more actively utilize Diversity Fairs as a mechanism for developing and spreading other local agricultural innovations. By the time

it reached Phase 3 (2013–2017), PIAL was operating in 45 municipalities across 10 Cuban provinces. Although it continued to be based at INCA, the third phase involved developing more integrated relationships with a range of institutions, including a growing number of research centers and universities, associations such as ANAP, the Association of Agricultural and Forestry Technicians (ACTAF), and the Federation of Cuban Women (FMC), state agri-businesses represented by the Ministry of Agriculture, as well as government agencies at municipal, provincial and national scales. This effort at institutionalizing the PIAL methodology was undertaken with the explicit aim of ensuring its long-term sustainability in the event that project-based funding was to be discontinued (Romero et al., 2018).

The fourth PIAL phase (2017–2021) has been marked by institutionalizing a *System* (as opposed to Program) of Local Agricultural Innovation (SIAL, for its initials in Spanish). The primary goal of this current phase of the work is to ensure that municipal governments, innovators, farmers, and other food and agricultural stakeholders draw upon the SIAL platform to solve regional agri-food production problems, with a focus on ensuring food security for the Cuban population. **Figure 1** indicates the provinces and municipalities where PIAL is active in this fourth phase.

Mainstreaming Gender Into the PIAL Methodology

During the third phase of PIAL's existence, the overarching goal was twofold: to facilitate the institutionalization of the methodology and its associated innovations into municipal plans, and to consolidate local working groups into spaces for “promotion of local agricultural innovation based upon dynamic, participatory processes wherein *women in rural communities participate and are the prioritized beneficiaries*” (Hernández Chávez and Romero Sarduy, 2015, p. 5, italics added). An appreciation of the importance of women's involvement in PIAL had been present since the early days of the project; however, it became more formalized in 2007 with the development of a PIAL gender strategy. This strategy built upon a pilot project conducted in four provinces under the umbrella of the PIAL, which had focused explicitly on creating opportunities for rural women. The inter-related objectives of the pilot were to: implement gender-focused participatory activities in support of women's development in an agricultural context; build upon existing capacities to facilitate increased integration of women into productive activities; enable women to access new income generating opportunities and dietary improvements; and, more broadly, strengthen women's participation in and impact upon their communities. In short, the work aimed to encourage attitudinal and material shifts in the roles women play within their households and communities (Benítez et al., 2012).

Based on the success of the pilot and the effectiveness of the 2007 strategy, gender became an even more central element of the PIAL methodology in its third phase, as gender mainstreaming was identified as one of four foundational themes for the work, along with technological and genetic diversity, climate change adaptation and mitigation, and inclusion of youth (Romero et al.,

2018). In addition to dedicated funding for gender-focused work, specific actions that supported the mainstreaming of gender into the PIAL methodology included: (1) the person who had been coordinating the gender-based PIAL work became part of the National Coordinating Group; (2) research and training that was explicitly focused on gender-specific issues became a permanent part of the program; and (3) needs and priorities identified specifically by women became the starting point for developing new programming. These broad actions led to a wide range of activities aimed at ensuring gender considerations were central within the PIAL. For example, workshops aimed at challenging toxic masculinities and patriarchal norms were offered to both women and men, Local Agricultural Innovation Groups that only included women were created, and food preservation was established as a line of innovation to be promoted via the PIAL methodology (Romero et al., 2018).

Key Elements in the PIAL's Gender-Specific Work

PIAL is a complex framework involving a wide range of actors and activities. Here, we briefly outline seven key elements that are essential to the approach, noting that, in practice these elements are all closely inter-related.

Element 1: Gender-focused participatory diagnostics. Through a series of workshops, farm visits and semi-structured interviews, farmers—along with cooperative leaders, representatives of ANAP and the FMC, agricultural officials and other key stakeholders—gather to identify existing roles played by both women and men in agricultural production processes, as well as their practical and strategic needs. The groups work to identify existing stereotypes, and facilitators use a variety of presentation and animation techniques to establish positive dynamics. Activities include using a 24-h clock technique that allows participants to describe their typical daily activities. In addition to outlining existing roles, participants collaboratively determine their aspirations for change, along with the required resources and strategies to enable that change. Using an “aspiration storm,” they describe their existing self-perceptions along with what they wish for themselves in the future. They also identify indicators for measuring change, for example the numbers of women and men who diversify their production or access new market opportunities, the number of women who report increased self-esteem, and the number of women who engage in building capacity of others.

Element 2: Capacity-building exchange workshops. Based upon the results of the diagnostic, workshops are designed to build participants' capacity in the areas identified by them as priorities. These workshops employ a social learning approach, wherein farmers learn with and from each other, sharing their individual knowledge, experiences, and areas of expertise. In some cases, external experts—for example women from other communities—are brought in as well, thus building bridges across the PIAL knowledge exchange network.

Element 3: Women-led Local Agricultural Innovation Groups (GIALs). Foundational to the organizational structure of PIAL

are these locally based groups comprised of farmers with shared interests. Drawing upon the principles of farmer-led research, the GIALs engage in on-farm experimentation and trials to develop and refine agricultural innovations, including agroecological production practices, technologies and commercialization strategies, and engage in active dissemination of results at the local, national and international scales. While women, men and youth can lead a GIAL, since the mainstreaming of gender into PIAL, increasing numbers of these groups are now led by women. As a result, the innovations that are developed through the groups increasingly represent women's knowledge and priorities.

Element 4: Spaces for Innovation. The physical spaces for innovation created through PIAL include Diversity Fairs, Innovation Festivals and Culinary Festivals. As noted above, Diversity Fairs have been central to the PIAL methodology from the beginning. While they were initially focused almost exclusively on seed selection, these fairs and festivals have expanded to reflect a broader range of agricultural innovations. In particular, as women's participation and leadership in PIAL has increased, their priorities have become better represented. The fairs and festivals provide space for women and men to gather, showcase the results of their innovations, exchange knowledge and experiences and, importantly, sell their products.

Element 5: Micro-Grants. As a mechanism developed to enable leaders in agricultural innovation to expand the scope of their work, micro-grants are made available on a competitive basis through the PIAL. While the grants are available to both women and men, women have been recipients of a significant percentage of the available funds thanks to the existence of the gender pillar of the work. For example, a study in Mayabeque Province found that 65% of grants were awarded to women. In some cases, the grants are used to finance on-farm research and innovation efforts (e.g., in pig-, rabbit- and poultry-rearing, fruit tree grafting, use of biofertilizers and other bio-products, and wine and vinegar production), while in others women have used the funds to support their ability to share their innovations and expertise with others (e.g., developing a capacity-building program in flower arranging). The latter allows women to share the knowledge they have gained through participation in capacity-building workshops and through their GIAL with others not directly involved in PIAL.

Element 6: Provincial, national and international exchange visits. While the PIAL methodology is heavily focused on supporting *local* agricultural innovation, facilitating knowledge-exchange at other scales is also important. As a result, the program includes workshops that bring together participants from various municipalities across a province, as well as from various provinces across the country. In some cases, participants have also traveled internationally to share their experiences and learn from others. Participation in these opportunities is organized in such a way as to guarantee equitable participation from both women and men. Such exchange is essential for constructing the kind of bridging social capital identified as necessary for spreading

agroecological innovation and, as will be elaborated upon below, the role women play in these processes is fundamental to their empowerment.

Element 7: Multi-actor management platforms. Finally, like the GIALs, the multi-actor management platforms are essential to the organizational structure of PIAL. While the former serve as the foundation for developing local agricultural innovations, the latter foster the institutionalization of the approach by embedding it within government and other institutional networks. They are led by municipal governments in communities where PIAL is active, and are comprised of officials from the Ministry of Technology and Environment (CITMA), the FMC, ANAP, and other key stakeholders and interested parties, for example representatives of other local and regional development programs that work in synergy with PIAL. Importantly, they also include members of the local GIALs. These multi-actor management platforms create opportunities to develop shared interests, policies and programs that respond to and enrich municipal development strategies and help resolve bottlenecks in territorial agri-food chains. For example, the platforms facilitate the integration of innovations and good practices developed and shared through the GIALs into municipal development strategies. They also facilitate the sharing of innovations across a larger network of provincial and national actors and decision-makers, enable government funding to be dedicated to support the spread of such innovation, and ensure the long-term sustainability of the approach in the event that international funding could be discontinued.

METHODS

The data presented in this paper are the result of research activities that took place between September 2013 and October 2015, during which time the gender-specific activities of the PIAL gained significant traction and became a more central pillar of the methodology. The work was conducted according to the principles of Participatory Action Research, which Greenwood and Levin (2005, p. 54) explain “aims to solve pertinent problems in a given context through democratic inquiry in which professional researchers collaborate with local stakeholders to seek and enact solutions to problems of major importance to the stakeholders.” This approach involves rethinking the role of the researcher through processes of collective knowledge construction and recovery that break with the subject-object binary typical of traditional research (Salazar, 1991). While such work is sometimes criticized for lacking rigor [see Mosavel et al. (2011), Levin (2012)], others argue that it can be just as rigorous—and in some ways even more so—than more conventional research approaches [see Davies and Dodd (2002), Brydon-Miller et al. (2003), Greenwood and Levin (2005)], in part because “it must demonstrate its credibility to a broader audience that brings a more diverse set of questions and standpoints to bear” (Warren et al., 2018, p. 448). Given the ways in which PIAL prioritizes knowledge co-creation and

Action Learning, designing and conducting the research from this collaborative perspective was appropriate.

The overarching goals of data collection were to assess the impacts of PIAL activities with respect to a number of key quantitative and qualitative indicators. These were established through participatory diagnostics wherein the core protagonists were farmers (women and men) from PIAL-associated farms, with facilitation provided by INCA staff, university professors and ANAP representatives. The qualitative indicators that were developed to inform data collection included: the kinds of work carried out by women and men engaged in PIAL; access to resources and opportunities, including leadership; living conditions and social status of PIAL participants; quality of female participation and leadership in PIAL activities; socio-cultural changes at the individual and household scales; and scope and efficacy of knowledge management and communication systems. A number of quantitative indicators were also employed, including: economic results of PIAL activities (income and employment); numbers of women engaged with or leading GIALs and Multi-actor Management Platforms; numbers of women managing seed banks; and percentage of leadership roles held by women. Due to the nature of the indicators that emerged through the participatory research design, the data that was collected was largely qualitative. While some scholars, funders and institutions favor quantitative research for its perceived objectivity and statistical generalizability, qualitative research has proven its importance in yielding rich, sincere, contextualized data that resonates with multiple audiences and can aid in understanding complex realities [see Denzin and Lincoln (2005), Tracy (2010)].

The team that collected and analyzed the data was comprised of provincial “gender mentors” representing a wide variety of institutions involved in the PIAL: INCA; the Facultad de Montaña of the University of San Andrés Pinar del Río; the Holguín Research, Extension and Training Unit of the Ministry of Agriculture; the “Marta Abreu” Central University of Las Villas; Matanzas province’s Experimental Pasture and Forage Station “Indio Hatuey;” the Sancti Spiritus University Centre “José Martí;” the University of Cienfuegos Centre for Agrarian Transformation Studies “Carlos Rafael Rodríguez;” the University Centre of Las Tunas; the “Jorge Dimitrov” Agricultural Research Institute; the AAA PIAL Project Office; COSUDE; the National ANAP Office; and the FMC. What is presented in this paper represents a relatively small fraction of the total data collected during the period, with other results used for other purposes, including program reporting and improvement.

The specific methods that were used to gather data were as follows:

1. *Household interviews with rural families participating in PIAL.* These interviews were conducted in early 2015 in the municipalities of Urbano Noris (Holguín Province) and San José de las Lajas (Mayabeque Province). In total, 208 people were interviewed (92 women and 116 men), with 73 interviewees representing “youth” under the age of 35. Interview questions focused on changes in female and male

identities with respect to roles, responsibilities and activities related to agroecological production and participants were selected based on their existing relationship with PIAL and willingness to participate in the research.

2. *Workshops with municipal and provincial level representatives of PIAL's gender work.* A series of three participatory workshops was conducted in September and October, 2015 in the provinces of Holguín (Gibara municipality), Pinar del Río (Bahía Honda municipality) and Villa Clara (Manicaragua municipality) with the goal of gaining an in-depth understanding of project challenges and successes with respect to the gender-focused activities.
3. *In-depth analysis of 200 PIAL demonstration farms across the country.* The project team selected four farms in each municipality where PIAL was active—for a total of 200 farms across the country – and collected detailed production-related and socio-economic data on each. These demonstration farms—referred to as “show of confidence” farms—were selected based on their level of engagement with PIAL and willingness to participate in ongoing data collection that would allow analysis of the project impacts over time and space.
4. *Participant observation.* The research team used this method to obtain in-depth information regarding the prevailing practices and attitudes in the families participating in PIAL across the multiple municipalities where it is active. Particular attention was given to observing the differentiated prominence of female and male roles in agroecological practice and innovation, as well as access to and control of resources.
5. *Review of print and electronic gray literature.* This review served to complement the primary data collected. Documents reviewed included PIAL project reports, reports from external evaluators, documentation of workshops and other PIAL activities, and statistical information about agricultural production and employment at the national, provincial and municipal scales.

RESULTS

Local Economic Development

One of the primary objectives of Cuba's PIAL methodology in its current iteration is to support local economic development opportunities, particularly for rural women, with the intention of increasing the economic autonomy of this segment of the population. Results demonstrate that, in 2014, PIAL activities directly contributed to employment opportunities for 739 women across seven Cuban provinces. By 2015, that number had grown to 2,393 across nine provinces, representing 30% of the total employment opportunities attributed to the PIAL. The average monthly income generated for women through their PIAL-influenced activities was 500 Cuban pesos (CUP). To put this in perspective, the average monthly salary for people employed in Cuba's state sector in 2015 was between 500 and 600 CUP (Díaz and Echavarría, 2019). Thus, the income generated for women through PIAL activities was essentially equivalent to an additional full-time salary for the household. Indeed, research

results demonstrated that, on average, both women and men from PIAL participating households saw a doubling of their monthly salaries, up to 1,200 CUP.

Due to the participatory nature of the methodology, the specific economic activities that women decided to engage in varied widely across households, communities, and provinces. Common activities include sales of floral arrangements, preserves, goat's milk cheese and yogurt, dried herbs, vegetables from home gardens, crafts and knitwork, and seeds. The production and sale of these goods were enabled by agricultural innovations introduced through PIAL Diversity Fairs and complementary knowledge-sharing and capacity-building workshops, as well as through support for micro-industry development. Some activities were also supported by local working groups (GIALs) comprised of women that, for example, encouraged active management of home gardens for food production and sale. **Figure 2** illustrates the total number of economic initiatives as well as jobs generated by women PIAL participants across eight Cuban provinces between 2013 and 2015. Importantly, all of the production carried out in connection with these initiatives was done using agroecological techniques, as will be outlined in more detail below.

While there is significant variation in the specific endeavors, what is common across participants is that engagement with PIAL fostered interest in and capacity to diversify the productive activity of farms and farming households (as demonstrated via examples in **Table 1**). For example, work in Mayabeque province [see Benítez et al. (2012)] illustrated how, through participating in a series of gender-focused activities, farming families in the municipality of San José de las Lajas introduced a wide range of new species to their agroecosystems. Research results demonstrated that in the initial phase of the project, farming families had very little or no biodiversity in their home gardens. This productive diversification, coupled with policy changes that have increased opportunities for private sale of agricultural goods in Cuba [see Nova González and Alfonso (2018)], has facilitated a significant diversification of income generating possibilities through sale of, for example, high value items like floral arrangements, meat, honey, fruits, and vegetables. These sales occur primarily in spaces created by PIAL, including the Diversity Fairs, Innovation Festivals, and workshops, and as a result of initiatives developed through PIAL support of micro-industry.

In addition to supporting diversification of production and access to markets, another element of the PIAL methodology that supports economic development opportunities is its program of micro-grants for women. These grants are managed at the national scale, and any woman from a province where PIAL is active who wants to develop a local agricultural innovation is eligible to apply. In 2014, 11 grants were awarded for projects ranging from flower seed production to increasing the efficiency of a worm compost operation to a project to develop craft-making using seeds and other agricultural by-products. In some cases, the grants were used to support existing initiatives, while in other cases women used them to develop new projects.

Research results demonstrate that the micro-enterprises created through these grants—as well as others developed

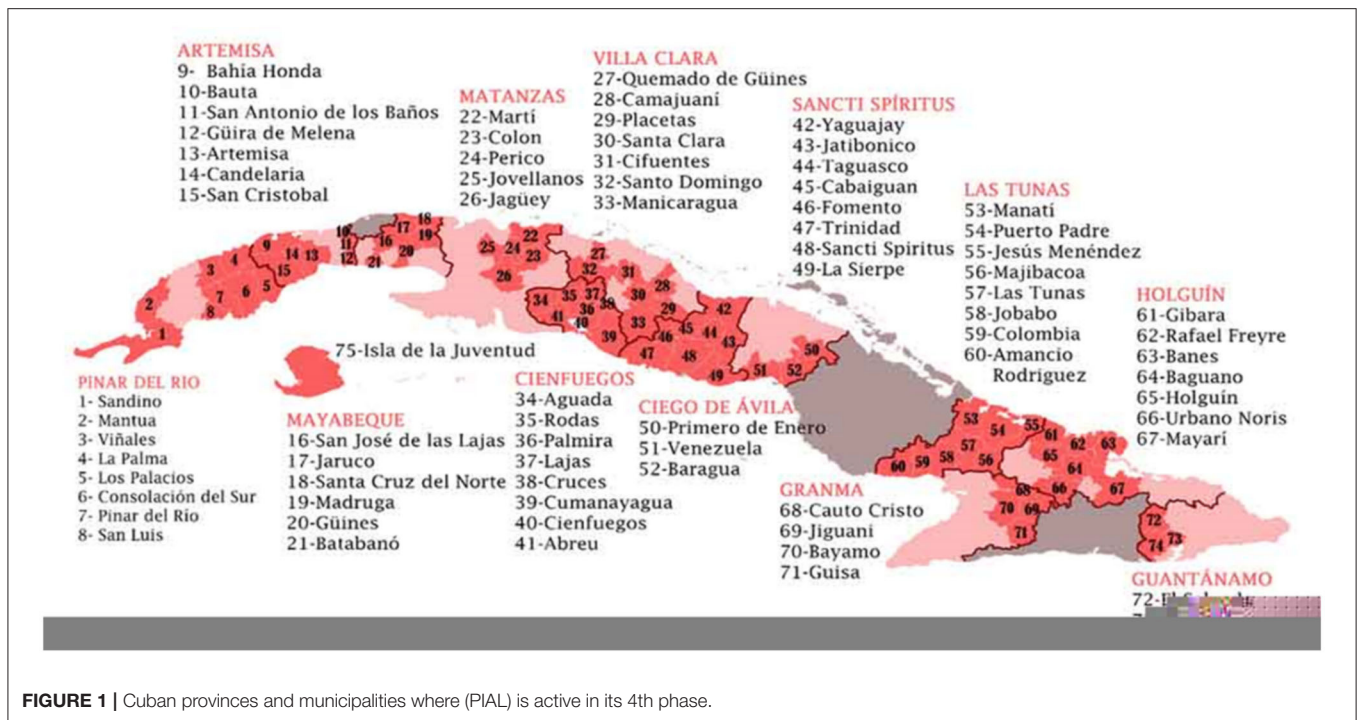


FIGURE 1 | Cuban provinces and municipalities where (PIAL) is active in its 4th phase.

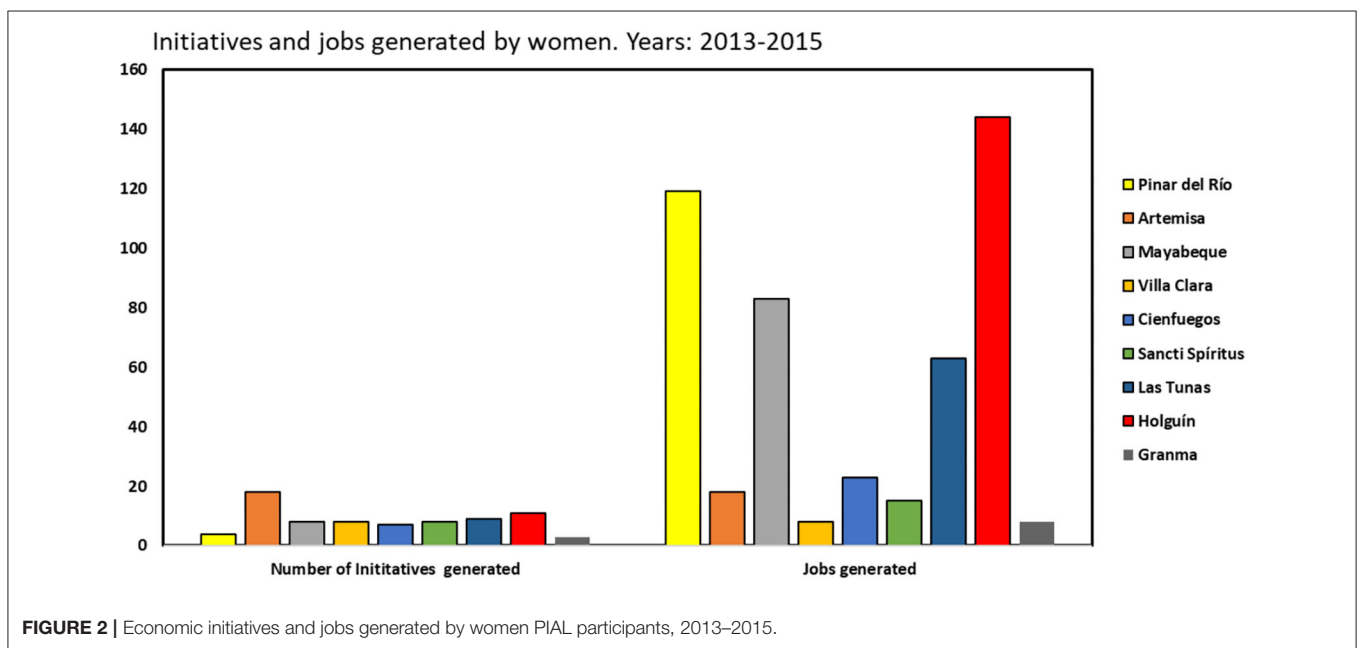


FIGURE 2 | Economic initiatives and jobs generated by women PIAL participants, 2013–2015.

without grant funding—are in some cases creating jobs for people outside the grantee household, thus increasing the scope of economic impact beyond PIAL participants and their families. For example, in the municipality of Bahía Honda, a juice stand employing local women was established at the nearby hospital, and in Las Tunas a participating farm was able to develop purchasing contracts with local and regional institutions and restaurants, creating 24 job opportunities in the process. Similarly, the program helped one woman from Mayabeque train

more than 200 women and men across 10 provinces in flower arranging techniques. The opening of at least eight new stalls for flower and ornamental plant sales, six of them run by women, can be traced back to that effort, and a point of sale was established in the provincial capital with monthly sales of more than 1,500 CUP. In addition, 10 of the trained women gained employment in flower arranging and were able to offer their services to state and private clients, and more than 100 people referenced the importance of being able to create floral decoration for the

TABLE 1 | Diversification of household economic activity as a result of PIAL in eight households, San José de las Lajas Municipality, Mayabeque Province.

2007–2010	2013–2015 (new activities through PIAL work)
Household Economic Activity	
1. Agricultural production	1. Flower and ornamental plant production 2. Food preservation 3. Flower arrangements
1. Off-farm employment	1. Food preservation 2. Meal preparation 3. Vinegar production
1. Flower and ornamental plant production	1. Food preservation 2. Poultry rearing
1. Agricultural production 2. Craft sales	1. Food preservation 2. Flower arrangements 3. Rabbit production
1. Old age pension	1. Ornamental plant production
1. Old age pension	1. Food preservation
1. Old age pension	1. Dried herb production
1. Off-farm employment	1. Ornamental plant production 2. Flower arrangements

beautification of their own home environments. Three women and one man from the municipality of Perico in the province of Matanzas were also able to draw on their training to open two sales points that are generating similar sales to the initial Mayabeque location.

Promoting Agroecology

As already noted, in its first phase, the PIAL was much more narrowly focused on the PPB and farmer-led research approaches that had been developed in other areas of Latin America, and the principle goal was to increase and protect genetic diversity on Cuban farms. Although the approach has significantly expanded in scope, it is still heavily grounded in building more biodiverse agroecosystems that are managed agroecologically. The aim of this paper is not to provide an in-depth account of the ecological benefits associated with the PIAL; however, results from the research on the gender-focused elements of the approach do still illustrate how participants are increasing their on-farm biodiversity, and also increasingly adopting agroecological practices. For example, innovative agroecological practices developed, shared and/or adopted by women engaged in PIAL include the use of biofertilizers and organic biostimulators to encourage vegetable crop growth, the use of seeds and other recycled agricultural by-products for crafts, the use of grafting to support introduction of fruit trees, incorporation of bees for pollination and honey production, recycling of bottles to use as seed containers, natural techniques for producing dried herbs, development of recipes using organically produced goods resulting from innovation, use of natural, locally-sourced animal feeds, and use of recycled and natural materials for floral arrangements.

An effective case study that exemplifies the processes by which PIAL promotes agroecology is provided by the experience of the “El Mulato” family farm, located in San José de las

Lajas, Mayabeque and run by Idalmis Castrillo Molina, Miriam Gallardo Álvarez, Yoel Hernández Gallardo and Yoel Hernández Castrillo. When the family initially began engaging with PIAL, its farm was characterized by limited crop diversity (beans, corn, pumpkin, cassava and limited vegetable varieties, along with fish, cattle and poultry) and significant agrochemical use. By 2015, the farm’s productive crops had been expanded to include: eight new varieties of beans; three new variety of chickpeas; multiple flower species; strawberries; local potato varieties; cabbage; yams; pigs; and goats. In addition, the family adopted a range of agroecological techniques: use of entomopathogenic nematodes; use of green cover crops; intercropping; creation of a seed conservation bank led by the women of the household; use of efficient microorganisms; use of vermicompost; introduction of living fences; use of locally produced animal feed; and application of biofertilizers and other bioproducts developed by the research centers located near the farm.

These changes were initially provoked through participation in PIAL-run capacity-building workshops and PIAL-led visits to other farms that were experiencing success with agroecological production. As the family became more engaged with the work, they also participated in PIAL Diversity Fairs, where they were able to practice participatory plant-breeding and seed exchange, thereby further increasing the biodiversity of their farm. Transitioning to agroecology has not only improved the health of the agroecosystem at “El Mulato” (for example by increasing soil fertility, adding populations of beneficial insects and decreasing pest populations), it has also helped the family increase their crop yields by ~30%. One of the defining characteristics of the way in which “El Mulato” has worked with PIAL and transitioned to agroecological farming is that it has been a family endeavor, with active participation of a husband-and-wife team, along with one of their mothers (who is engaged in flower arrangement and food preservation activities) and their son (who manages the farm’s pigs and goats). As a result of their success with agroecological production, as well as some of the social changes provoked by PIAL that will be discussed below, “El Mulato” has become a kind of demonstration farm that provides educational opportunities for students of the local Agrarian University and polytechnical institute, as well as visiting scholars and students from other parts of Cuba and around the world.

Social Change

While facilitating innovation, productive diversification and adoption of agroecological practices to foster local economic development and agroecosystem health are important endeavors in and of themselves, over time the PIAL methodology has increasingly adopted a vision of promoting broader social change, particularly with respect to gender relations in rural households and communities. The starting point for these efforts has been work to change attitudes and behaviors of individual women and men through participation in the PIAL, in part by building women’s capacity and confidence to engage in agricultural innovation and creating spaces for their active participation in activities locally as well as nationally and internationally, thereby increasing their autonomy and

self-esteem. Alongside explicit creation of space for women's participation and leadership, the PIAL approach includes work with women and men to tackle entrenched patterns of toxic masculinity and challenge deeply rooted patriarchal beliefs and behaviors using a Gender and Development approach.

Participants in the program noted changes in household dynamics, specifically a lessening in traditional *machista* divisions of labor. According to one woman: "Since the PIAL activities, the emphasis is on helping with household tasks, sharing household income and expenses, deciding what to do with income, a situation that was not like this before the gender work began." A male participant echoed this perception, noting that "the men [who have participated in PIAL] have changed a lot, because the women now work in the fields and we work in the house." Yet another confirmed that his "social, personal and family life has changed a lot; we used to be very *machista* and we have had to change, to learn how to do things in the home." In Mayabeque province, a male PIAL participant talked about the first time that the family farm had been left entirely to the household's men as the women traveled to a week-long capacity-building workshop: "I never imagined that my father and I would take over household tasks so that the women could have a chance to better themselves after all these years..." Another male participant suggested that such changes have not only benefitted women, but have also allowed men to become "more free" from the limitations of strictly bounded gender norms regarding household roles and responsibilities. These benefits are echoed by another participant's story regarding the impacts of PIAL, which he joined when, following the death of his father, he took over management of the family farmland and his wife began managing the *organopónico* (peri-urban garden) that he previously ran:

She (my wife) has become my right arm. We have created employment for our children... [PIAL] has allowed us to help the community, an ill child, a local maternity home, and an old age residence with fresh, clean products and this makes me feel very happy and very motivated, and I am so grateful to PIAL. I hope it will always be with us. Before I became involved in the work, I was the owner of the *organopónico* but now that I am more involved in the project, my wife is in charge there...

Such changes in perception regarding what constitutes "women's work" have, over time, been accompanied by an increased rate of female participation in the agricultural innovation and development work supported by PIAL (see **Table 2**). The data in **Table 2**, which measures indicators developed through participatory processes to track improvements in gender equality, shows that women have become important protagonists in agricultural innovation processes. On an organizational level, they play a strong leadership role in locally based GIALs as well as in the larger-scale multi-actor platforms. Equally important are the significant number of women managing seed banks, points of sale, and artisanal-scale agri-food industry. The increasing number of women engaging in these activities, particularly in a leadership capacity, is closely related to concerted efforts by those involved in PIAL to move the needle on the gender equality indicators developed by communities,

and it represents significant attitudinal shifts as well as positive impacts for quality of life at the household and community scale (Benítez et al., 2012).

As already discussed, the shifts in attitude and practice that have enabled increased female participation in agricultural innovation processes have led to significantly increased economic opportunity—and autonomy—for participating women. One female participant made an explicit link between this economic opportunity and broader processes of social change: "From the moment that women were incorporated in the PIAL, they had a way to support themselves, because it has generated employment; they contribute to the family economy; they're no longer ignored; they can make their own decisions." Referring specifically to perceptions of rural men, another participant argued that, following engagement with PIAL, "the [male] producers in the region now see women as a fundamental part of every activity they are carrying out."

While shifting male attitudes is certainly a goal of the PIAL's gender-focused work, the most striking findings from the research conducted were regarding women's own shifting attitudes about their skills, capacities and worth. Comments from women regarding the impacts of PIAL were overwhelmingly positive, with many specifically noting that it fostered: changes in attitude; personal self-transformation; increased self-esteem; transformation toward greater equity; independence; and, empowerment. One woman elaborated on these themes, explaining that PIAL participation created the "opportunity to recognize in oneself and teach to others that we are valuable, important, independent." Another who participated in a workshop in Cienfuegos province noted that her needs and dreams were "a necessity for high self-esteem, to feel realized as a person, to value oneself, have professional achievement, health, economic solvency, the [farm] cooperative growing always, and that peace ceases to be a dream." Through their involvement in PIAL, women felt empowered to be protagonists in their own learning processes, while simultaneously contributing to others' learning.

Part of the transformation described above was sparked simply by opening space for increased female participation in agricultural innovation and the accompanying economic opportunities; however, two other components of the PIAL approach played an important role. Firstly, the gender-focused work has included active promotion of women into positions of leadership, for example as leaders of local GIALs, as key decision-makers setting the agenda for PIAL efforts from the local to the national scale, and as representatives speaking for PIAL across the country and on the international stage. One participant explained that "even when *machismo* still exists, [through PIAL] we have had activities to highlight the role of women as producers, and women have built their capacity outside of the municipality and internationally."

As they increase their capacity and confidence, women also take on leadership roles outside of PIAL, for example in their cooperatives and municipalities. In some cases, such leadership includes representing their communities nationally and/or internationally. One participant underscored the importance of such opportunities: "women have traveled to national and

TABLE 2 | Indicators of women's participation in agricultural innovation in seven Cuban provinces.

Indicator	Pinar del Río	Arte misa	Maya beque	Santi Spíritus	Las Tunas	Granma	Holguín
Number of GIALs led by women	4	53	56	13	5	15	34
% of GIALs led by women	30.8	37	27	100	100	40	100
% of women leading multi-actor platforms	42	67	50	3	71	57	25
Number of women managing seed conservation, use and sales	71	35	9	12	24	30	29
Number of women leaders in productive units	22	5	67	9	5	96	210

international exchanges; they have the space to gather, to develop themselves, to exchange, to socialize their knowledge and they become more economically independent.” Related to these leadership opportunities, the PIAL has strengthened participants’ connectivity to organizations such as ANAP and the FMC with, for example, rural women from PIAL participating in the former’s national congress. As will be elaborated upon below, the building of such institutional connections is a central element of the PIAL approach and fundamental to its success.

DISCUSSION

Re-Valuing Campesina Culture and Empowering Rural Women

Agroecology is often framed as a pathway for re-valuing traditional farming practices and, in so doing, re-valuing the peasant cultures from around the world that are associated with such practices and have been systematically *de-valued* by the dominant conventional food system model (see Altieri et al., 1987; Altieri and Toledo, 2011; Pimbert, 2018). As such, it is linked to a reclaiming of peasant—or *campesino*—identities as embodied in the work of *La Via Campesina*, its growing number of member organizations, and associated groups (Desmarais, 2007; Pimbert, 2018). If agroecology generally can be viewed as a means by which the value of *campesino* identities and cultures are reaffirmed, the results presented in this paper demonstrate how the PIAL methodology explicitly reaffirms *campesina* (literally female peasant) identities and cultures as well. One participant explained how, prior to the PIAL work “the tradition of food preserving had been lost, and with PIAL it has been taken up again.” Through its support for activities such as food preserving, herb production, small-scale animal rearing, flower production and arrangement, and craft-making, the PIAL is able to position activities that have traditionally been the domain of rural women as central to municipal and regional development strategies, for their economic as well as ecological and socio-cultural value. Through supporting women to re-establish and innovate these practices in ways that are consistent with Cuba’s transition to agroecology (e.g., integrating use of biofertilizers, natural biostimulators, compost, and local, natural animal feeds and inputs), PIAL renders women’s agricultural knowledge and labor visible, and positions *campesinas* as active leaders in Cuba’s agroecology movement. In her Uruguayan case study, Oliver (2016) presents similar results, noting how women’s agricultural knowledge emphasizes agroecological concepts such as agrobiodiversity and seed-saving. The PIAL results confirm Oliver’s assertion that “women’s empowerment and the advancement of agroecology are inextricably linked” (Oliver, 2016, p. 39), an argument that is reflected more broadly

in the emphasis that organizations such as the Agroecological Movement of Latin American and the Caribbean (MAELA) and the *Via Campesina* place on gender equity [see Desmarais (2007)].

Coupled with a re-affirmation of the value of traditional *campesina* activities, PIAL has involved *explicitly* challenging traditionally entrenched gender norms in rural households and communities. The directness of this challenge sets the PIAL methodology apart from many other farmer-led research, PPB and agroecological development initiatives, which demonstrate significant gender-related impacts [see Classen et al. (2008), Rosset et al. (2011), Humphries et al. (2012), Bezner Kerr et al. (2019)] without so *directly* confronting patriarchal values. In the case of PIAL, as the methodology evolved, it actively expanded beyond its initial plant breeding focus to foster innovation in everything from flower arranging to vinegar production, and now also includes workshops on gender norms, gender-based violence, self-esteem, and associated issues that further serve to pull at tightly woven knots of male bias. Just as this focus sets PIAL somewhat apart from its participatory farmer research and learning cousins (e.g., the CIALs and Farmer Field Schools), it also creates certain challenges for measuring impact, with Van den Berg and Jiggins (2007) explaining how, in the case of Farmer Field Schools, it is much easier to define and measure impacts such as changes to yields or pesticide use, while “[o]ther, less tangible, but not less important, parameters” including gender roles and empowerment are inherently more difficult to assess.

This considerable expansion of what constitutes “agricultural innovation” not only provides more space for women’s involvement in PIAL, it also centers women’s knowledge and expertise, their capacity to innovate, and their role as leaders and decision-makers in community development. In so doing, PIAL’s equity orientation confronts head-on some of the deeply gendered power imbalances that construct men as the primary generators, holders, transmitters and users of agricultural knowledge and innovation [see Classen et al. (2008), Cockburn (2015), Pimbert (2018), Bezner Kerr et al. (2019)]. As the research results demonstrate, this confrontation has resulted in concrete changes to the gendered division of household labor, as well as to broader conceptions of gender roles at the community scale. Such results are consistent with findings by Schwendler and Thompson (2017, p. 111), based upon work with Brazil’s Landless Peasant Movement, that when agroecological education is coupled explicitly with “gender-oriented pedagogy” the results empower “women and men to disrupt the traditional sexual division of labor in rural communities...”

Integral to the PIAL efforts at social change is the active fostering of inter-generational knowledge exchange through

inclusion of youth in the project's gender-based activities. This focus on young people is something that Goris et al. (2019) argue is fundamental for transitions toward agroecology. In the words of one research participant, working actively with youth on issues of both agriculture and gender ensures that "a new household culture is being transmitted to boys and girls." This integration occurs in a variety of ways. Local GIALs collaborate with community youth clubs, and there are a number of cases where youth have taken on leadership roles within the GIALs. PIAL participants also work with primary school children and students at polytechnical institutes through collaborations with school-based "interest groups," thereby connecting large numbers of young people to agricultural activities and good practices. Finally, PIAL includes strong collaboration with university students, creating opportunities (referred to as "*convivencias*" or coexistences) for them to visit the homes and farms of *campesinas* and *campesinos* to work with and learn from them, again drawing upon principles of social learning.

As a result of this suite of inter-generational efforts, insights and impacts from PIAL are being actively incorporated into curricula in Agronomy as well as Socio-Cultural departments at a variety of universities across Cuba. The ways in which Cuban youth are learning and reproducing new attitudes about agriculture and society through involvement with PIAL is reflective of the need to challenge power dynamics, engage traditionally marginalized actors, and build relationships across a diversity of groups if social learning for agroecology is to be effective (Carolan, 2006; Cockburn, 2015; Pimbert, 2018). It also exemplifies Goris, van den Berg, da Silva Lopes, Behagel, Verschoor and Turnhout (2019, p. 20) discussion regarding the importance of youth involvement to ensure that agroecological transitions are founded upon "repeasantization that reworks local culture so that it is more inclusive of different populations, generations and genders."

The ways in which the PIAL methodology has fostered a revaluing of *campesina* culture and a rethinking of gender roles and norms in farming households and communities has facilitated a broader process of empowering rural women. Such empowerment is widely considered to be an impact of the kinds of social learning, farmer-led research, and PPP initiatives from which PIAL has drawn inspiration (Hassanein and Kloppenburg, 1995; Ashby et al., 2000; Classen et al., 2008; Humphries et al., 2012). It is also closely associated with the agroecological paradigm, particularly when viewed in connection to a food sovereignty framework. Pimbert (2018, p. 263) elucidates these connections in describing the kind of democratization of knowledge required to enable meaningful agri-food transformation:

Instead of being seen as passive beneficiaries of trickle-down scientific development or technology transfer, farmers and other citizens are viewed as knowledgeable and active actors who can be centrally involved in both the "upstream" choice and design of scientific innovations, and their "downstream" implementation, spread and regulation. In this context, science and the construction of knowledge are seen as part of a bottom-up, participatory process in which citizens take center stage

in decisions on what knowledge is produced, why, how and for whom.

While the focus of such analysis is on empowering farmers—particularly small-scale or peasant producers—as a general category, the argument is especially relevant in the case of women farmers, who face additional layers of marginalization. This is where the PIAL methodology offers perhaps its most useful lessons, as it represents a means by which the production and reproduction of agricultural knowledge and innovation can truly be democratized in a way that is inclusive and empowering for, not just small-scale farmers, but specifically the women in their ranks.

Increasing Capacity for Agroecology as a Science, Set of Practices and Social Movement

While the focus of this paper has been on the gender-specific activities and impacts of PIAL, the model is important for the broader ways in which it increases capacity to construct local, regional and even national agroecological food systems. The foundation for this is PIAL's focus on fostering farmers' ability to generate, refine and share agroecological innovations, from improved seed varieties to techniques for applying biofertilizers and other bioproducts to recipes and techniques for food preservation. Consistent with the FAO (2019) definition of agroecological innovation, farmers drive the process, however, they collaborate closely with researchers from institutions such as INCA. As such, in accordance with Pimbert (2018, p. 12), innovations emerge "through respectful intercultural dialogue between scientists and farmers/citizens, building on peoples' local priorities, knowledge and capacity to innovate." The reciprocal farmer-scientist relationships allow farmers to apply and adapt agroecological innovations developed in an institutional setting (e.g., biofertilizers and organic growth stimulators produced by INCA), while their own farm-based innovations feed into the scientific system (e.g., through integration into university curricula and field testing of products and technologies).

This PIAL innovation process brings farmers—women and men—into the science of agroecology, creating spaces within which they participate as active investigators and knowledge mobilizers, developing, refining and sharing innovative practices that contribute to furthering the discipline. In so doing, the work addresses critiques regarding agroecology's exclusion of local and traditional knowledges [see Méndez et al. (2013), Fernandez et al. (2013), Snipstal (2015)] and, following Pimbert (2018, p. 261), represents an alternative to the "top-down research and the hegemony of scientism, as well as the current privatization of research and commodification of knowledge" that are sometimes characteristic of agroecological science. By contrast, PIAL furthers a more inclusive discipline of agroecology wherein knowledge and innovation are co-created and shared openly and collaboratively by a wide variety of actors. This approach is in accordance with an agroecology "built around a plurality of knowledge systems" (Coolsaet, 2016, p. 165), and acknowledges findings that agroecological science

and innovation is most effective when co-created and shared through collaboration and exchange amongst a diversity of actors including farmers and scientists, along with other civil society actors (Carolan, 2006; Humphries et al., 2015; Pimbert, 2018; FAO, 2019). It is similarly consistent with the Farmer Field School approach, which challenges prejudiced views regarding farmer ignorance by positioning them as capable researchers, innovators and co-creators of scientific knowledge (Pimbert, 2018).

This collaborative generation and sharing of knowledge and innovation facilitates increased capacity for and uptake of a wide range of agroecological practices on farms across Cuba, for example with producers in Granma Province developing agri-food chains that enable organic cilantro production, and many PIAL participants producing organic dried herbs and other condiments. The drivers for these and other innovations are first and foremost the producers themselves, as is consistent with notions of agroecology as a set of practices grounded in empirical knowledge held by farmers (Gliessman, 2014). Following agroecology's emphasis on local ecologies, knowledge and resources (Altieri and Toledo, 2011; Rosset et al., 2011; Anderson et al., 2018), practices also prioritize the use of locally available, and sometimes undervalued or under-utilized resources. For example, producers have begun to use yucca flour as an alternative to wheat for preparing breads, cookies and other deserts, the yucca itself to prepare a yogurt alternative, and they have developed a series of recipes using a variety of garbanzo produced by an INCA-based PIAL working group. Similarly, in their flower arrangements and other craftwork, women and men are using local, often recycled, elements such as banana plant trunks and seeds. Replacing expensive, often imported, resource-intensive and difficult to obtain goods like wheat flour with agroecologically produced alternatives better adapted to local ecologies and economies, highlights how agroecological practice can contribute to a region's food security (Altieri et al., 2012; IPES-Food, 2016) and sovereignty (Pimbert, 2018) and also to a revaluing of locally-based cultural traditions (Altieri and Toledo, 2011).

Central to the spread of these agroecological practices are the Innovation, Culinary and Agricultural Festivals wherein women and men exhibit their agricultural innovations, exchange with other producers, and have an opportunity to sell their products. A cornerstone of the PIAL methodology, these festivals foster the kind of social capital and social learning that has proven central to expanding agroecological practice (Hassanein and Kloppenburg, 1995; Schneider et al., 2009; Ingram, 2010; Cadger et al., 2016; Pimbert, 2018). In particular, they serve to foment the essential bridging linkages that are especially important in facilitating agri-food innovation (Isaac, 2012; Nelson et al., 2013). For example, they bring together producers of different types (e.g., age, gender, farm structure) from regions across the country and, because they are generally held in urban areas, they include active participation of both farmers and non-farmer citizens, with the latter learning about agricultural innovation (and agriculture more generally), tasting products, buying goods for their households and engaging in communication and exchange of ideas with their farmer compatriots. They also support a strengthening of relationships between producers and civil society organizations such as ANAP, which organizes

agricultural fairs in which many PIAL participants engage, and research institutes such as INCA. Supporting these ties between farmers, civil society and research organizations is an important element of the methodology and is consistent with findings from Honduras (Humphries et al., 2015) and Ghana (Isaac, 2012) suggesting that networks of diverse actors including farmers, research centers and NGOs are best positioned to effectively enable uptake of agroecological innovation.

In addition to furthering an inclusive model of agroecological *science* and building capacity for agroecological *practice*, PIAL uses agroecology as a platform to contribute to a broader movement for transformative social change. This includes coupling agroecological science and practice with a food sovereignty orientation, as small-scale farmers diversify their agroecosystems as part of Cuba's deliberate strategy of leveraging agroecology "as part of its struggle to sustain national food security and domestic sovereignty" (Fernández et al., 2018a, np). It also refers to the farmer-led methodology employed by PIAL, which challenges top-down models of agricultural—including agroecological—research and extension efforts that continue to be widely used, even in Cuba where more participatory processes have gained traction (Rosset et al., 2011; Fernández et al., 2018a). Beyond this farmer-led orientation, the strong focus on not just including, but empowering rural women that has characterized later phases of the PIAL highlights the methodology's transformative potential. This finding positions PIAL within a limited but growing body of scholarship documenting the ways in which agroecological initiatives, when accompanied by explicitly gender-based elements, support women's capacity to engage in social mobilization and collective action and advocate for themselves and their communities (Classen et al., 2008; Humphries et al., 2012; Schwendler and Thompson, 2017; Bezner Kerr et al., 2019).

A prerequisite for such collective action to be effective is the presence of social capital [see Flora and Flora (2006)]. Thus, by strengthening both bonding and bridging linkages, PIAL not only fosters farmers' ability to engage in social learning to co-create and apply agroecological knowledge and innovation, but also builds their capacity to engage with agroecological social movements within and outside of Cuba. This begins with the GIALS, the model's most micro-scale organized units that bring women and men together based on shared interests in a particular aspect of agricultural development and innovation. The social bonds developed through these groups are foundational for building participants'—and particularly women's—confidence and leadership skills, with many GIAL members eventually taking on leadership roles in their cooperatives and communities, as well as with organizations like ANAP. The strong and lasting relationships evidenced in the PIAL case are similar to the CIAL model as practiced in Honduras, while contrasting somewhat to the Farmer Field School model, which tends to be characterized by less sustained long-term relationship-building (Tripp et al., 2005; see Humphries et al., 2012). Connectivity to ANAP, along with other civil society, research and governmental institutions is central to PIAL's ability to affect systemic change, and there have been significant efforts in recent years to extend and solidify these relationships in order to help institutionalize good practices developed through the program. To that end, PIAL works closely

with ANAP, the FMC, the Ministry of Agriculture, research centers like INCA, universities and municipal governments, and like-minded programs and organizations internationally to share its results and good practices and further collective action for more sustainable, agroecological and equitable food systems. For example, it offers a nation-wide certificate program and series of shorter courses and uses its multi-actor management platforms to integrate PIAL practices and approaches into municipal and regional development plans. Taken together, such efforts to leverage relationships with institutional actors in order to spread its farmer-led, gender-sensitive approach to agroecological development and innovation enable PIAL to increase the scope of its impact beyond the lives and agroecosystems of its participants. In so doing, the model takes up Pimbert's (2018, p. 285–286) call for an institutionalization of participatory agroecological knowledge systems, embodying the idea of “local organizations and collective structures that facilitate the ‘scaling out’ of grassroots research and innovation” and “have a potentially key role in ‘scaling up’ policies and practices designed to democratize public research on food, agriculture, environment and society.”

CONCLUSIONS

Over the past 20 years, PIAL has evolved from a relatively small-scale program dedicated to participatory-plant breeding to increase the diversity of Cuba's seed stock, to become a holistic framework for advancing sustainable, equitable, agricultural development and innovation grounded in the principles and practices of agroecology and a commitment to women's empowerment. True to its roots, the model continues to increase agrobiodiversity, in part by ongoing PPB efforts, but also by supporting participants to introduce new plant and animal species into their agroecosystems and facilitating use of biological inputs and other agroecological innovations that build populations of soil micro-organisms and beneficial insects. These increases in biodiversity serve an important ecological function, helping increase agroecosystem resilience, while simultaneously creating significant economic impacts as producers diversify their income sources through sales of new products.

Beyond the ecological and economic impacts of the work, PIAL has catalyzed transformations in gender relations in participating households and communities, as its gender-specific activities have created new spaces for women's participation and leadership in agricultural innovation processes. This work is not easy, and it is certainly not complete. However, through PIAL, both women and men are learning to take on new roles and identities, women's knowledge and labor is rendered visible and valuable, traditional *campesina* activities are foregrounded in economic and community development plans, and rural women gain a sense of agency and empowerment, thus enhancing their overall well-being. In so doing, PIAL serves as a compelling example of how agroecological development efforts can contribute meaningfully to SDG 5, Achieving Gender Equality. By deeply incorporating this gendered work into its methodology, PIAL also provides a framework for how to further agroecology as a science, set of practices and social movement in

a way that strives for social equity as well as economic viability and ecological integrity.

One of the primary limitations of the research presented here is that it includes only data up to and including 2015. Preliminary observations suggest that more advances with respect to gender empowerment have been made in the ensuing 5 years. For example, the numbers (both in absolute and percentage terms) of women participating in agricultural innovation activities supported by PIAL has continued to grow, and women are similarly taking on more leadership, for example playing key roles in the transition to a Local Agricultural Innovation System (SIAL). Future research is needed to continue systematizing and demonstrating how and why these gendered impacts are occurring, particularly as the methodology becomes increasingly institutionalized across Cuba.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the data is held by researchers at Cuba's National Institute of Agricultural Sciences and is not available in anonymized form. Requests to access the datasets should be directed to Barbara Benítez, bbenitez@inca.edu.cu.

ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

BB, MR, RO, AC, CC, MC, AMB, AMM, and YH were involved in design of the work along with data collection and analysis. EN and BB led the writing including collaboratively drafting all content. JD contributed to the review of literature. The final manuscript for submission was read and approved by EN and BB. All authors contributed to the article and approved the submitted version.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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