Chapter 42. From participatory plant breeding to local innovation networks in Cuba

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[a]Introduction

At the beginning of the last century, plant breeding was gradually removed from farmers' hands, with the result that what had been done by many, many people in many diverse places was being done by fewer and fewer people in relatively few places (Cecarelli et.al. 2012).

Today participatory plant breeding (PPB) has brought farmers back into breeding (Almekinders and Hardon, 2006). Actually, farmers are participating in research activities in the field of seed conservation, plant/animal breeding, seeds selection, varieties/crops diffusion, farming system improvements and business management, opening multiple windows to maximise positive effects initiated with PPB.

PPB emerged as an alternative to reach better impact in heterogeneous environments. The heterogeneity of farming systems and farming itself forced scientists to go beyond their own discipline and work and interact with others, including the farmers, to improve their livelihoods. In practice, farmers and scientist from fields as diverse as sociology, economy, anthropology, agronomy, business management have been inspiring plant breeding, thus becoming a modern science field producing new knowledge and practices based on collective action.

This chapter provides an example of how PPB led to strengthening local innovation systems in order to improve food security in a centralised socioeconomic system.

[a]The Golden Age of Conventional Plant Breeding in Cuba

During the 'golden years' of the eastern socialist countries, a centralized plant breeding model was a standard component of the high-input agriculture practised in Cuba, and particularly for the country's cash crops. Wide geographical adaptation characteristics were encouraged by policy-makers, with most Cuban governmental organizations providing incentives to scientists involved in releasing a variety to State Enterprises characterized by large areas of land in monoculture (between 1,000 and 100,000 hectares). This was accompanied by intensive mechanization, high agrochemical inputs and the construction of enormous artificial irrigation systems.

In the 1980s, ambitious plant breeding programmes were developed for sugar cane, root and tuber crops, rice, tobacco, coffee, horticultural crops, pastures, grains, fibres and some fruit trees, undertaken by fifteen research institutes and their corresponding governmental networks of experimental stations that spread over the island. Heterogeneous, disease resistant and low input varieties were only accessible to professional plant breeders, and farmers were not involved in these breeding programmes.

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Before new varieties were released, they went through a rigorous scientific evaluation, and the research institutes had to send their results to the National Scientific Forum (*Consejo Científico*), which checked the scientific results and, if approved, in turn sent them to a so-called Expert Group (*Grupo Expertos*), consisting of researchers, lecturers and production directors of the big state enterprises. If this group also approved the results, they were forwarded to the Vice-Minister for Mixed Crops (*Vice-Ministro Cultivos Varios*), who in turn would send the results to the provincial delegations, which would incorporate them into their provincial production plans, and the state enterprises were then obliged to use the selected varieties in their production system, a rather top-down approach without consultation of local state producers.

Following the collapse of the Eastern Block in 1989, the Cuban agricultural sector had to cope with a drastic reduction in inputs and trade support, shifting gradually towards more self-sufficient forms of production.

Many remarkable technical and social transformations occurred as a response to this challenge. In the 1980s, Cuba had carried out 87% of its external trade under preferential price agreements, imported 95% of its fertilizer and herbicide requirements, and owned one tractor for every 125 ha of farm land. After the collapse, foreign purchase capacity was reduced from USD8.1 billion in 1989 to USD1.7 billion in 1993. This greatly affected the country's ability to buy agricultural inputs (Funes, 1997). The collapse generated a deficit of energy, supplies and chemicals, and forced significant changes in the ways in which food was produced and distributed in Cuba. Due to these deficits, in the 90s, Cuba moved from being the largest consumer of agrochemicals in Latin America to one with vast experience in organic agriculture in the world.

This transition period went hand in hand with a severe economic depression and the income of scientists, lecturers, technicians, government employees and the public sector in general became so low that many professionals emigrated to look for better opportunities elsewhere. In this process of change, state enterprises gradually lost importance in the production and supply of food for local consumption, and low-input family farming emerged, to supply local markets instead.

The new low-input agriculture in Cuba and the diversity of crops now produced by these farmers led to significant differentiation of production systems and hence specific seed demand. The public plant breeding sector was uncertain about how to deal with the diversity of seeds now demanded by small farmers. In the remainder of this chapter, we discuss how this led to the development of plant breeding programmes of a participatory nature.

[a]The emergence of participatory plant breeding in Cuba

At the beginning of the 90s, an Optical Neuritis outbreak quickly spread across Cuba due to widespread vitamin A deficit. In 1992, the Central government of Cuba asked the National Institute of Agricultural Sciences (INCA) to breed pumpkin (*Cucurbita moschata* Duch). At that time, the government seed company only had available one pumpkin variety which covered 40,000 hectares of the country, representing effectively 100% of the total area covered of this crop. Due to the new 'silver leave' disease combined with limited irrigation (not enough oil available for pumping water) and limited chemical disease control, the yields of pumpkin diminished nationwide from 2-.3 ton/hectare to less than 0,5 ton/hectare

Two approaches were taken to seek improved pumpkin genetic material. The first was to explore the possibility of purchasing modern seed varieties (MV) from international seed companies. The government acquired different varieties from such companies for testing under Cuba's new, low-input conditions. The second approach was to test, under low-input conditions, a sample of landraces from the national gene bank managed by the National Institute of Fundamental Research in Agriculture (INIFAT), in charge of ex situ conservation.

Overall, the twenty MVs tested had very low yields, high pest and disease infestations and poor culinary quality (Ríos et al, 1996). In contrast, within the pool of 33 landraces evaluated, favourable variation was found for some characteristics important for the new breeding programme. During the 1993 summer season, two veteran farmers from Batabanó District (58 and 70 years old) were involved in the selection process and they chose among 13 *half sib* families according to yield and fruit shape and selected individual fruits within those chosen families. Afterwards, the chosen families (represented by selected individual fruits) were sown at the same time by the two farmers on-farm and at the INCA experimental station under low-input conditions during the cool and dry season and after four breeding cycle two new pumpkin varieties were released.

Table 42.1 shows a comparison of plant breeding practices under high-input agriculture and those described here, carried out under low-input conditions. The comparison is made in terms of energy consumption, inputs used on farm and farmers' participation.

Table 42.1 *Comparison of input use and results of pumpkin breeding strategies in Habana Province*

Indicators	**Pumpkin breeding before the special period (1980s)**	**Pumpkin breeding under conditions of the special period (1990s)**
Mineral fertilization (kg ha^{-1})	Nitrogen: 42 Phosphorus: 39 Potassium: 62	0
Organic soil amendments	Rarely applied	Typically 6-7 tons ha^{-1}
Frequency and amount of artificial irrigation (summer season)	9-11 times $season^{-1}$, 2000 m^3 ha^{-1}	2-4 times $season^{-1}$, 200 m^3 ha^{-1}
Number of varieties released in 10 years	1	2
Varietal maintenance and seed multiplication	Isolation	Cross pollination
Pest and disease control	Agrochemical intensive	Biological
Use of honey bees	Sporadically	Frequently
Yield	6-8 tons ha^{-1}	6-8 tons ha^{-1}
Farmer participation	Contracted seed production	On farm selection of half sib families
Researcher participation	Screening germplasm and varietal evaluation and selection. Cross pollination control	Screening germplasm, facilitating availability of new germplasm, evaluation of variety with farmers
Energy requirements (kcal ha^{-1})[a]	Fertilization: 679,000 Irrigation: 10,160,000 Pesticides: 6,160,000 Total: 16,999,000	Fertilization: 42,000 Irrigation: 3,697,200 Pesticides: 88,000 Total: 3,827,200

Source: Ríos, 1999

The crop improvement programmes performed under low-input conditions were more efficient in terms of energy use. Notably, the yield obtained under the low-input conditions was also comparable to yields achieved under the conventional, high-input technological package. The economic impact of varieties selected under high – as compared to low – input conditions was evaluated by growing the most popular variety disseminated in Cuba, which was named *RG,* under low-input conditions, as well as two varieties selected collaboratively with farmers under those low-input condition (**Table 42.2**).

Table 42.2 *Economic impact of pumpkin breeding under low input conditions*

Indicators (calculated as averages)	**Varieties bred under high input conditions sown in low input conditions (Top down approach)**	**Varieties bred and sown under low input conditions (On farm, with farmers participation)**
Cost ha-1 under low input condition (Cuban pesos)	702.3	708.3
Fruit yield (tons ha-1)	1.5	6.7
Total income (0.16 Cuban pesos kg-1)	240	1080
Net income ha-1 (Cuban pesos)	-462* *average net loss	372
Benefit/cost ratio	0.34:1	1.5:1

Source: Ríos, 1999.

This first experience of working on-farm, with farmers and Cuban pumpkin landraces provided to INCA plant breeders four important insights:

**Wide phenotypic variability of useful traits exists among Cuban landraces grown under low-input conditions. It is possible to increase production by selecting directly for fruit yield under low-input conditions.
**Genetic advance was higher on farmers' field
**Farmers had the capacity to choose varieties locally adaptive. They understood better than professional plant breeders which types of varieties local farmers preferred.
**INCA plant breeders realised: 'Farmers can be plant breeders like us, they just need to have access to diversity of seeds'

[a]Widening the scope towards participatory plant breeding

Inspired by the first impact on participatory pumpkin breeding and other international experiences on participatory plant breeding, INCA plant breeders felt the necessity to involve other disciplines, crops and consider new locations to involve farmers as plant breeders.

A first multidisciplinary team was formed, including representatives of INCA, the Agrarian University of Havana and the Centre for Psychological and Sociological Research. This team developed a Participatory Seed Diffusion (PSD) process that was implemented between 2000 and 2007. Initially PSD promoted maize and improved beans varieties and landraces in 'seed diversity fairs' as an approach where plant breeders, farmers and extension agents had access to diversity in one or more crops over La Palma, Batabanó and San Antonio de Los Baños districts. Varieties from formal and informal seed sources were sown under the usual cultural practices of the target environment and farmers had the possibility to choose 4/6 varieties per crop in the field.

In the diversity seed fairs (**Figure 42.1**), participants did not know the seed sources in the plot during the selection exercise and only afterwards the varieties identity was revealed. Subsequently the farmers organised trials with selected seeds on their own farms and discussions on varietal performance took place within the communities between farmers and researchers. Around 35-100 maize, beans and rice varieties were displayed and farmers were invited to select 5-7 varieties for each crop. After selection the researcher provided between 20-200 seeds of each chosen variety to the farmers to take back home for testing.

Figure 42.1 *Farmers choosing varieties in diversity seed fairs in the Northeast 'Las Caobas' village, Holguin Province. (Photo: H. Rios)*

In this period, as never before, culinary aspects were considered, woman organized cooking evaluations as a new criteria in varietal selection (**Figure 42.2**).

Figure 42.2 *Sweet potatoes culinary test organized by women of La Tunas province (Photo H. Rios)*

Mostly male farmers voted for varieties with high yield and associated characteristics. Female participants voted for varieties related to culinary properties. In the cooking test, men noted that more than 80% of the varieties tested were of good quality, whereas women were more rigorous (see broader discussions of the importance of gender in the conservation and sustainable use of agricultural biodiversity in Jiggins, Chapter 34 of this volume). This is not surprising given that Cuban women do most of the cooking, but in conventional breeding, culinary aspects had seldom been considered (Rios et. al., 2012).

INCA scientists had to reconsider their conventional belief that farmers could manage no more than six varieties and few crops and that diversity had to be gradually released otherwise 'crop diversity would make farmers uneasy'.

One of the main impacts of farmers participation was the increasing number of crops handled over time. The approach began with maize and beans, but six years later more than twenty crops were in the hands of the farmers' experimental network and crop yield and number of varieties managed by farmers increased significantly (**Table 42.3**).

Table 42.3 *Crop yield and number of varieties in La Palma, District, and Pinar del Rio province over four years of PSD*

	Crop yield (t/ha)		**Number of varieties**	
	Before PSD	After four years of PSD	Before PSD	After Four years of PSD
Tomato	8.0	12.0	3	42
Maize	1.4	2.4	4	52
Bean	0.4	1.4	5	200
Rice	1.9	3.8	6	45

Source: Rios, 2009

By the end of 2007, 7000 farmers from 49 communities, 850 research and extension workers and 258 policy makers of five provinces were participating in the PSD (Rios, 2007). Due to increased yield, crop diversity and the mobilisation of small farmers around seed diversity, an increasing interest emerged by new villages, local universities, government and NGOs to be part of the process. Over the coming seven years the multidisciplinary team engaged with local district government staff and gradually managed to have them embrace PSD, and they participated in the organization of new seed diversity fairs with more crops and then a chain reaction process took place in different regions of Cuba (Rios 2009). The farmers' fields turned into a potential small experimental station, with fellow farmers selecting varieties and receiving small amounts of the seed varieties they had selected, with the farm turning into a "diversity nucleus" of its own right. Then more farmers copied the process, creating new diversity seed nucleus and expanding seed diversity (Rios 2009).

A strong farmer led experimental network emerged that initially only considered maize, beans and rice seeds, but gradually moved to other crops and agro-ecological practices (Rios, 2009). Today, this innovation network (5 universities, 5 research stations and 2 NGOs) plays a crucial role in disseminating good agricultural practices to over 50 000 farmers in currently 45 districts (INCA-PIAL, 2016).

The multidisciplinary team realised that the PSD process had evolved from a technological into a social learning process. Through PSD ninety five community seed banks managed by farmers were created (Ortiz and Acosta 2013) and diversity seed flows strongly intensified within and between communities as well as with conventional seed banks.

Farmers reinforced their experimentation capacity by testing, adopting and diffusing seeds from formal and informal seed systems; researchers learnt how to facilitate seed diversity and knowledge exchange among farmers, research organisations and NGOs. In short, PSD created a learning community of farmers, NGO representatives and researchers, believing that only together they could transform the Cuban rural reality.

It was extremely important that ownership of the PSD process had been transferred to farmers and 'champions' at district level (see 'Because it is ours', Taylor, Chapter 39 of this volume). Reflecting, one may say that the multidisciplinary team from INCA, the Agrarian University of Havana and the Centre for Psychological and Sociological Research brokered the emergence of PSD in Cuba.

[a]Expanding participatory approaches in Cuba

The promising results achieved during the first seven year of PSD prompted the team and partners to amplify the pilot experience. They were eager to find out how PSD could be adapted to others parts of the country with different biophysical and socioeconomic features.

How to scale-up the PSD while maintaining a dynamic, open process based on the collective actions of various stakeholders? In terms of what to scale, the team decided on the following:

**Keeping the practice of seed diversity fairs, farmer experimentation and local seed multiplication with various crops, but this time organized by district stakeholders and providing also benefits to the participating farmers
**Local stakeholder should look into specific local challenges, and should be supported in becoming also owners of the solutions, not just of their problems.
**Encouraging 'conventional' research organizations and universities to work directly with farmers, facilitating access to genetic diversity and agro-ecological practices.
**Building up capacity to broker innovations at two levels, at district level where farmers and local organization generated new evaluation of the performance of PSD in the field, and at the national level where public policies are decided.

This new expansion wave beyond PSD focused on a bottom-up approach, involving farmers and key local stakeholders in the search for best agricultural practices, giving birth to the 'Local Agricultural innovation Programme' (*PIAL-Programa de Innovación Agropecuaria Local*). PIAL has been using the action learning approach promoted by ICRA geared towards stimulating experiential learning (learning-by-doing) and purposeful interaction to adapt and coordinate activities, taking 'learners' through facilitated on-the-job learning cycles (**Figure 42.3**).

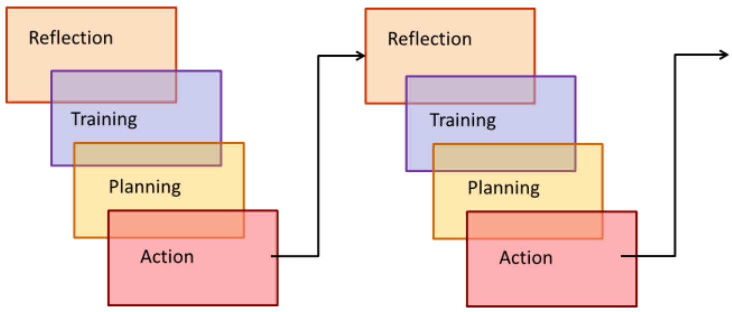

Figure 42.3 *Interactive learning cycles (Source: ICRA training material 2012)*

The 'interactive learning cycle' engages all relevant actors, i.e., those actors and stakeholders that really faced a common innovation challenge and stand out to profit from joint learning and action (**Figure 42.4**). Actors reflect on the challenges they face, learn how to deal with them, plan how to apply the lessons learnt and then apply them in their own working environment.

However, for an action learning cycles to be successful, it requires someone to bring all actors together and keep them geared in the jointly agreed direction (Rios and Ceballos, 2016). PIAL identified ‘champions’ who had excelled in the previous years and with the support of a professional facilitator trained them on-the-job as innovation brokers or facilitators

Figure 42.4 *Event organised by a learning group to share drafting technique. The workshop was led by a champion farmer in Madruga District, Mayabeque Province. (Photo E. Calves)*

Over the course of eight years, five learning cycles were conducted at district level in different regions of Cuba, applying in each cycle a two-track interactive and experiential learning approach. 'District champions' were identified from different organizations (including university lecturers, researchers, technicians and farmers) and trained on-the-job as innovation facilitators/brokers. As a key component of the training the 'District Champions' facilitated a learning cycle with a group of actors and stakeholders coming together to address a specific challenge at their working places.

For instance in Guisa District, a specific challenge was access to food at reasonable prices. As in most of the country, the national government supplies food to local consumers through a ration card which only is good for 10 days of the monthly family food intake. Consumers are forced to access the rest of their food either at free market shops downtown which are only open during normal working office hours or access through vendors at far higher prices. In particular, public workers are neither able to be at the market shops in time nor afford the high prices of the vendors.

A representative of the local government of Guisa championed and facilitated a learning cycle to come up with a solution (**Figure 42.5,** *Learning cycle to promote the 'Green Baskets' as alternative to local food supply*), A group of local actors (farmers, local radio, and education workers union, consumers) came up with the idea of organising a food delivery service for local consumers, called 'The Green Baskets', which could deliver food outside working hours and at better prices than those of the vendors.

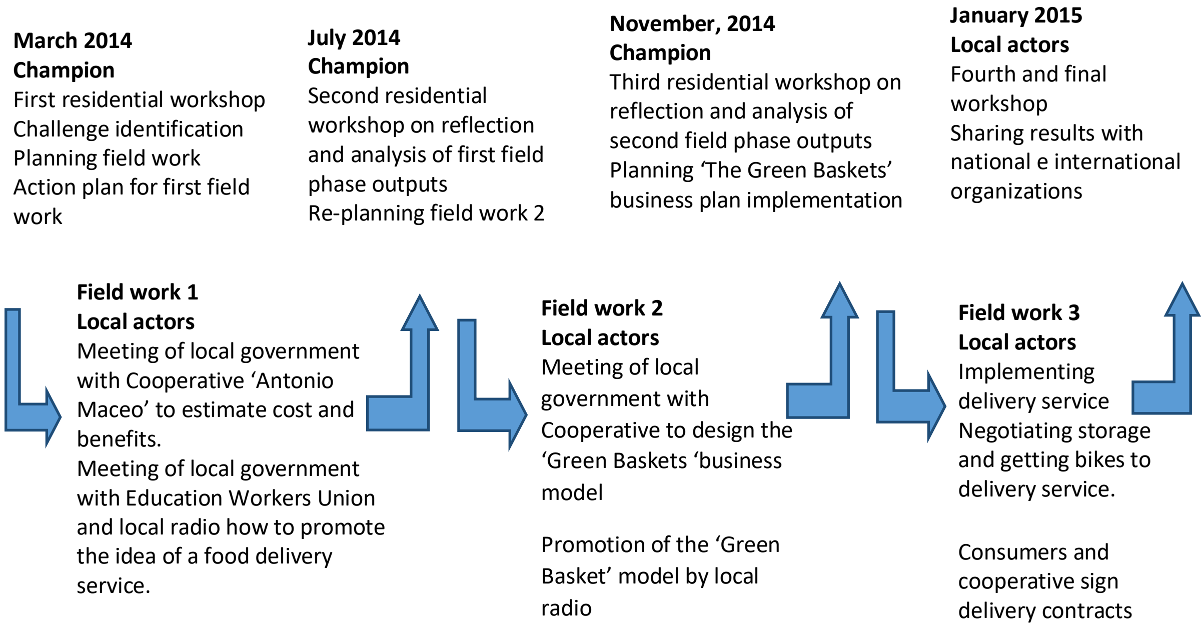

Figure 42.5 *Learning cycle to promote the 'Green Baskets' as alternative to local food supply, Guisa District, Granma Province.*

By the end of 2011 more than 19,500 farmers had access to seed diversity as well as agro-ecological practices promoted by PIAL and a significant impact on family farming was demonstrated before and after the introduction of participatory approaches in Cuba (**Figure 42.6**). Ortiz and De la Fé (2013) demonstrated that community seed bank management by farmers had had a significant impact in improving their farming systems, but that the availability of certified seeds had not, due to the fact that these seeds had limited local adaptation and poor germination percentage (below 70 %).

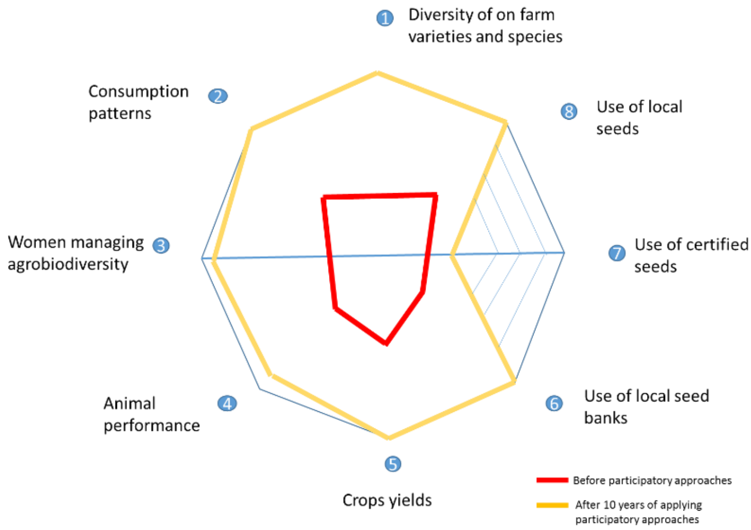

Figure 42.6 *Impact of interactive learning cycle to enhance livelihood Improvement. Farmer survey, Source Ortiz and De la Fé, 2013*

[a]Cuban government announces political changes

Taking advantage of the fact that by 2014 the Cuban government had started promoting self-employment (*por cuenta propia*), PIAL also started exploring alternative approaches to make farming more sustainable and economically viable. In two further learning cycles (2014-2015), an interactive learning approach was developed to catalysing business ideas. Again learning groups were formed with key local actors, and joined by farmers who had previously shown themselves to be business-minded. The groups jointly started identifying business ideas, the feasibility of which was then tested in the field. Between March 2014 and January 2015 some thirteen business ideas were brought forward, analysed and validated by the learning groups using the CANVAS business model[2]. Two business ideas are exemplified in boxes 1 and 2 below.

Photo 42.6 *Gina, a farmer participant of an action learning cycle explaining her cooperative business model to commercialize local seeds in Jesus Menendez District, Las Tunas Province. (Photo H. Rios)*

Due to the fact that most Cuban farmers still have relatively little access to agro-chemical inputs, they are typically agro-ecologically oriented by default. It was therefore natural to emphasize this and start referring to them as ‘green’ (agroecological) entrepreneurs in the aforementioned process of turning farming into a business as well.

Farmers and other participants of the learning cycle were extremely motivated by the newly introduced entrepreneurial perspective and eager to follow the CANVAS model, visualising their value proposition, clients, commercialisation channels, strategy to keep relationships with clients, business partners and investments. In short, farmers could actually think and act as small business people, even using the PIAL Logo as a market brand for their local products (see Jager and Giuliani, Chapter 31 of this volume, for a broader discussion of the importance of marketing of agro-biodiverse products).

[2] CANVAS business model is a strategic management and entrepreneurial tool. It allows one to describe, design, challenge, invent, and pivot a business model. http://www.businessmodelgeneration.com/downloads/businessmodelgeneration_preview.pdf).

Example 1 The Market Garden

“*I used to farm using monocultures and chemicals. It is harder work to farm ecologically, but I notice the difference in the soil and in the taste of the food.”* (Statement from Roberto Ochoa, 2015)

Entrepreneurs: Roberto Ochoa and Dania Roja, Cooperative Frank Pais, Gibara District
Selling Product: Community market garden
Background: They have 1600 families in their community.
Business Description: The idea came from the university and the community working together: farmers wanted a place to buy vegetables, a community market garden. Roberto had a *finca (farm)*, so they thought it would be a good idea to situate the garden there, and he and his wife both participated in the business model workshops. In an arid zone and with problems with accessing water, they are constructing a well, at a cost of 7000 pesos (290 American Dollars). There is also a micro dam and a turbine, and plans to establish a *Punta de Venta (selling point)* on the Cooperative. They will employ 5 women who will earn approx. 300 pesos/month each (13 American dollars).
Future plans: To undertake schools education on the market garden.

Source: Wright and Vargas, 2016

Example 2 An entrepreneur couple

“*Before we made the business plan with the project, we thought that ‘business’ was illegal, and we knew nothing about obtaining bank loans*.” (Statement from Miguel Leyva, 2015)

Entrepreneurs: Juan Miguel Leyva Fidalgo y Mayte, Finca el Renacer, CCS Jose Manuel Rodriguez
Selling Products: Farm machinery and pigs
Background: Juan is a mechanical engineer and also produces biofertiliser and sells this product and trains other farmers to make it. Mayte is an agronomist.
Business Description: Both Juan and Mayte made business plans with the project. Mayte went on the business training course. She started her business in January with 10 pigs, and spent 10,000 pesos on feed, supplemented with sweet potato, cassava and forage plants, as well as with the biofertiliser. The feed is milled in order to obtain a better conversion rate. The pigs are sold whole, between 85kg and 120kg. She decides what to do with the profit.
Juan’s first business idea was to make biogas, then he changed this to an idea to help local women make some income. The women are in an Art and Agroforestry group, making artisanal trinkets from local materials such as shells and wood. The trinkets sell at 10 pesos (42 American Dollars Cents) for larger ones, and take 1 day to produce 10. At the same time developed another idea as he’d read that equipment is a limiting factor for agroecology, so he obtained funds from the project for some basic tools and lends his services to producers to undertake soldering and making agricultural equipment. He developed a seed planter that took 3 days to make, and he hires this out and makes a profit. To undertake the planting takes one man and one ox or horse for one day; without the machine takes 2 oxen and 2 men for one day for the same job. He could produce a lot more equipment but the CCS isn’t organised to make a contract with him so he couldn’t be paid. Every month he advertises his services in the Cooperative meetings, but finds he gets more interest from elsewhere.
Future plans: He’s currently applying for a 50,000 peso (2083 American Dollars) bank loan for an agrotourism project, and plans to develop a large ranch and offer food and women’s handicrafts, with women attending to the tourists. He is also now pursuing the biogas idea again.

Source: Wright and Vargas 2016

Cuba was forced to change from an industrial agricultural model into a more agro-ecological one. Under low inputs conditions of the sort encountered in many developing countries, farmers were nevertheless able to improve yield crops.

Access to agrobiodiversity, experimentation and seed multiplication by farmers, choosing seeds according to their own criteria, has made plant breeding processes both more participatory and demand-driven.

Moving from a participatory plant breeding initiative towards local innovation networks, family farmers became key players in this process. Important for this was a bottom-up approach, which started at local (district) level and gradually extended to include other actors at provincial and even national levels. One major factor contributing to the success of this scheme was the fact that the learning groups focused on real challenges farmers were facing, and that facilitators were available and well trained to move the groups to action, and collectively work towards solutions.

This 'action-based learning approach' (**Figure 42.7**) is a valuable method to promote change in the rural institutional landscape. The approach helps in achieving a common understanding among a group of people as diverse as local government (representing the state doctrine), other public organisations (still rather conventional oriented) and emerging, more business-minded farmers.

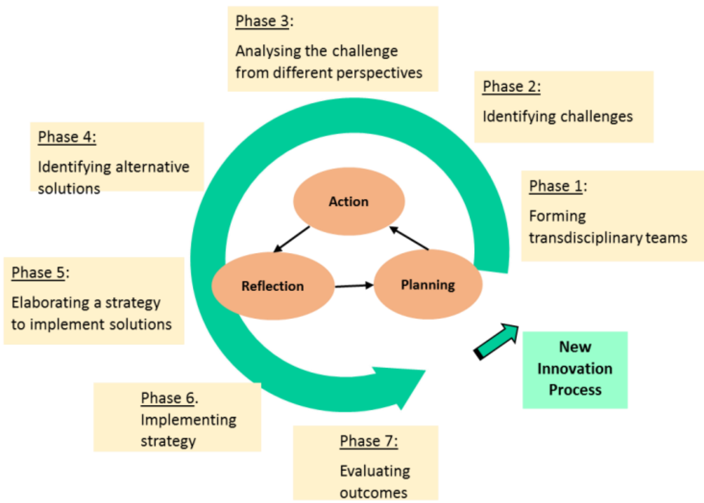

Figure 42.7 *ICRA's Action Learning Approach. Source: ICRA training materials 2014*

Forming brokers who themselves formed learning groups (i.e. a two-track approach) was a successful technique for generating innovations appropriate for use in the local agricultural system. Many local 'champions' became catalysers of innovations and learnt to link different public stakeholders and farmers in a joint collective effort to introduce changes at local level.

Even so, in the last few years, the brokerage efforts have increasingly concentrated on incorporating entrepreneurial perspectives in farming and supporting the emerging business ideas of small farmers. A future threat for these small farmers might be competition from big-agribusiness that may develop in the wake of improving relations with other countries, especially the United States, which could bring an influx of agricultural products and agribusinesses in the future. It will therefore be important to continue the development of farmers' business skills and ability to identify market niches.

In 2015, after 25 years of innovation brokerage and action learning, over 50.000 farmers have been reached in all 10 Provinces of Cuba and have benefitted from action learning through the PIAL network (**Figure 42.8**).

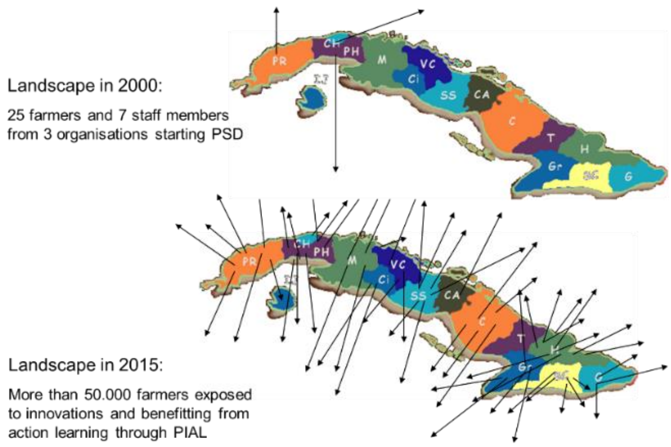

Figure 42.8 *Evolution of action learning and innovation brokerage in Cuba. Source: Rios and Ceballos, 2016*

In the process of moving from a participatory plant breeding initiative towards local innovation networks, the role of professional plant breeders and farmers have changed. Farmers on the one hand have shown the capacity to improve cash crops like pumpkin, maize and beans, have successfully integrated many crops into their farming systems and finally have begun to introduce an entrepreneurial perspective to their interactions with communities, and with public and private actors. On the other hand, professional plant breeders are now working together with farmers to achieve seed diversity and convincing district, provincial and national policy makers to jointly develop plant breeding and agro ecological practices diffusion programmes with farmers, thus joining forces to improve farming system and benefit also from national and international solutions.

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