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Livelihood of Sheep-Raising Families in the Eastern Region of Cuba

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Abstract: This study analyzes Livelihoods (LH) of Sheep-Raising Families (SRF) in nine communities with three types of land tenancy in the Cauto Valley Region of Granma, Cuba. The study consisted of the following stages. First we analyzed the history of agriculture on a regional scale by reviewing secondary information sources. Second, on a community level, through participatory workshops, we analyzed the families vulnerabilities, institutional context and values. Third, on the SRF level, through participatory workshops and interviews with farmers, we analyzed Livelihood Strategies (LS) based on income strategies and capitals or resources. Finally, in another set of participatory workshops, we developed a process for social learning based on the LH workshops. This process consisted of identifying the problem, proposing possible solutions and evaluating and selecting alternatives which might be put into practice. Results show the following: first, Cuban agriculture has undergone technological, economic, social and environmental changes from the stages of settlement, growth, maturity and collapse to the current stage of renovation through agro-ecological innovation and organic production. Second, the most significant vulnerability factors have been the economic blockade against Cuba, market dynamics and natural disasters. Policies, laws and the economic context have affected the community in a variety of ways and the families values such as fidelity, respect, solidarity and patriotism have helped them cope. Third, the LH of the SRF are heterogeneous and diversified. The LS of workers of the Basic Units of Cooperative Production are primarily based on wage labor and to a lesser extent agriculture while the LS of small-scale farmers with their own land and those with land in usufruct are principally based on agriculture and to a lesser extent wage labor. Total family income ranges from 532-1,028 US dollars annually of which sheep raising provides between 4.9 and 24.4%. The SRF have strong social and human capital while natural, physical and financial capitals are weak. The most pressing problems identified for the three types of land tenancy are deforestation, environmental contamination, disturbed natural vegetation and soil degradation. Innovations proposed by the families to address these problems comply with sustainable land management criteria.

Key words: Livelihood, annual income, capitals, vulnerability, social learning, management criteria

INTRODUCTION

Analysis of family farming as a complex system allows for understanding and describing diverse livelihood strategies used by families as production and consumption units to assure their well-being and sustenance (Chonchol, 1996). These livelihood strategies in turn directly depend on income strategies.

Livelihood strategies refer to the combination of families activities and decisions aimed at attaining certain objectives. These strategies may positively or negatively impact family welfare, biodiversity and natural resources.

Livelihood strategies were defined by Chambers and Conway (1992) as the values and activities carried out by families to attain their life objectives according to their economic, social and political capabilities, opportunities and liberties (Rello, 2001).

Several proposals for improving families economic systems in Latin American nations have been based on research and theories without taking into account families capacities, values and opportunities and their participation in technology development (Mosse, 2003). Research based on a model of specialization and vertical knowledge transfer has paid little attention to the importance of local farmer innovation (Calderon *et al*., 2011). Thus, there is a need to incorporate alternative approaches to respond to the current context of family farming (Rodriguez *et al*., 2009).

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One approach used in several studies to address livelihood strategies of farm families has been Sustainable Livelihoods (SL). The SL conceptual framework proposed by the DFID is a tool for conceptualizing families livelihoods. This approach has been further developed by several organizations including the FAO in Latin American and African nations (Neely *et al*., 2004) as a new way of describing family systems which allows for a more profound analysis of rural contexts.

Several organizations, including the UNDP and CARE have used the SL framework in order to program, evaluate and follow up on projects; to evaluate environmental sustainability (Carney, 1999, Kabir *et al*., 2012) and to study the issue of food security (Pat-Fernandez, 2010). Also, Aguilar *et al*. (2012) has used this approach to evaluate the extent to which cattle raising systems approximate the organic production standard. These researchers affirm that different livelihood strategies have obtained varied outcomes with respect to the compatibility of existing livestock raising systems with organic livestock raising principles, natural resource conservation and obtaining profits.

In Cuba, farm families have been found to practice varied income strategies which directly correspond with their livelihood strategies (La, 2013; Sosa *et al*., 2011; Garcia and Yero, 2011 and Rios, 2011). Addressing these strategies with the holistic SL approach allows for better understanding them. Research on Cuban family systems enriches the broad diversity of information based on use of the SL framework which is available on an international level as it enriches analysis of livelihood strategies and construction of joint knowledge by researchers and farmers as well as designing of proposals for intervention with community participation.

In this manner, the SL approach visualizes people in their environment, placing them in the center of the investigation and describing and analyzing resources, activities, vulnerability contexts and lessons learned by the families who participate in economic, social and environmental development of their farm systems (Ellis, 2000; Rocheleau, 1999 and Cleary *et al*., 2003).

Based on these premises, the objective of this study is to characterize livelihoods of Sheep Raising Families (SRF) in the Cauto Valley in eastern Cuba and propose a social learning process based on SL in order to identify existing problems and propose possible solutions.

MATERIALS AND METHODS

Study area: The study was carried out in the municipalities Bayamo, Jiguani and Cauto Cristo in the Cauto Valley in Granma Province. This valley is situated to the North of the Sierra Maestra mountains and South of Holguin Province. With an area of 2114 km^2 it makes up 25.3% of the province's total surface (ONE., 2012).

Climate is warm tropical with two well-defined seasons: the rainy season from May-October and the dry season from November-April. Average annual precipitation is 1088.8 mm and average annual temperature 25.4°C, ranging from 22.9°C during the dry season to 27.9°C during the rainy season. The 100% of soils used for livestock in the region are characterized by poor drainage, 70% by salinity and 40% are flood prone (Benitez, 2003). Soil salinization levels vary, depending on distance from the ocean from salinized water tables and from fields irrigated with poor quality water (Ray, 2000).

Table 1: Communities selected for characterizing sustainable livelihoods according to their form of land tenancy in the Cauto Valley, Granma, Cuba

Form of land tenancy	Communities	Place	Variables
PA	La Concepcion	Cauto Cristo Oeste	Cautillo
PU	Santa Maria	Cauto Oeste	Cautillo merendero
UBPC	Papi Lastre	Raul Sanchez	Batalla de peral

Scale, methods and data taking and analysis

Regional history: In order to characterize the history of agriculture in the region (Dosi, 1982; Possas *et al*., 1996) secondary information sources principally historic archives and published articles on socioeconomic aspects, agriculture and history were consulted.

Family unit: This study was carried out with 90 families from nine randomly selected communities (La Concepcion, Cautillo, Cauto Cristo Oeste, Santa Maria, Cautillo Merendero, Cauto Oeste, Papi Lastre, Raul Sanchez, Batalla de Peralejo) (Table 1). The families of these communities to a greater or lesser extent raise sheep, according to three forms of land tenancy: small-scale land-owning farmers (PA), usufruct farmers (PU) and workers of the Basic Units of Cooperative Production (UBPC) (All abbreviations of Cuban forms of land tenancy and organizations are according to their Spanish initials).

The general methodology used in this study is based on the SL framework. Information on capitals, strategies, the vulnerability context and the institutional context was obtained in community workshops with farmers and their families through participatory evaluation (Chambers, and Conway,1983; Geilfus, 2001) and other activities addressing Livelihood (LH) concepts (Herrera *et al*., 2005).

Parallel to the workshops, interviews were carried out with three key informants of each community (an exemplary farmer, the community's municipal delegate and a farm organization president) in order to obtain additional information on certain aspects addressed in the workshops (Vela, 2001).

Capitals, livelihood strategies and livelihood outcomes: In the workshops, information was obtained regarding natural, financial, physical, human and social capital for each form of land tenancy, taking into consideration the criteria listed in Table 2. In order to determine family LS,

Table 2: Criteria used to evaluate capitals in the communities of the Cauto Valley, Granma, Cuba

Capitals	Criteria
Natural capital	Land and water conditions, precipitation, natural vegetation
Physical capital	Services to which the families have access (education, health, transportation, communication) and work equipment and facilities
Human capital	Formal educational level, agricultural knowledge and producer age
Social capital	Civic and agricultural organizations as actors in the communities economic and social processes
Financial capital	Income received by families for economic activities (agriculture and wage labor)

we assumed that each family pools their resources to obtain the greatest benefit and make the best use possible of their capabilities. LS include agricultural activities and a broad variety of non-agricultural activities (Ellis, 1999) and were evaluated here by calculating the percentage contribution of each economic activity to total family income. LH were analyzed according to family income from different activities within their LS.

Workshop participants, based on their perceptions, shared and analyzed relevant information regarding all their resources including access to funds and daily management of all their resources.

Vulnerability factors: To determine the vulnerability factors of the region, a variety of activities were carried out in each community workshop, based on the community planning manual by Parra *et al.* (2011). Furthermore, secondary information sources were reviewed regarding events and policies over which farm families have no control but which influence their abilities to attain better living conditions.

Values which propitiate sustainable livelihoods: During the workshops, participating families recognized those values that they share as community members which foment sustainable livelihoods.

Prioritizing problems: Structural analysis was used as a systematic method to identify interactions and group problems which characterize a system (Godet, 2001). As a result of the community workshops, 27 interviews with key informants and information offered by researchers and specialists of the Institute for Agricultural Research Jorge Dimitrov (IIAJD) twelve problems were identified for the PA and PU systems and seven for backyard production of the UBPC workers. Double entry motricity and dependence matrices were constructed, displaying the interactions of the problems; a problem was given a value of three when it strongly influenced another; two when the influence was moderate; one when influence was weak and zero when there was no influence. The sum of the columns represents the dependence index-the number of times a problem is dependent on the others. To prioritize problems, the MICMA Software was used and two graphs were obtained which group the problems on a cartesian plane whose axes are the dimensions motricity and dependence. Thus, the problems are grouped into four areas or zones:

- Power with high motricity and low dependence
- Conflict with high motricity and high dependence
- Autonomy with low motricity and low dependence
- Exit with low motricity and high dependence (Godet, 2001)

Evaluation of sustainability of alternatives: This stage was initiated by locating alternatives developed in different provinces of Cuba which were then characterized according to the type of problem they resolve (soil degradation, contamination, disturbed natural vegetation and deforestation) and the advantages they offer agricultural systems including cattle and sheep raising. To evaluate sustainability of the alternatives, eleven criteria from the proposal for sustainable land management by Smith and Dumanski (1993) were used these were judged as appropriate for workshop participants to be able to achieve sustainable land management. Each alternative was evaluated with respect to each criteria; a value of 1 was assigned when it did not comply with the criteria, 2 when it partially complied and 3 when it completely complied with the criteria.

Social learning: Community research was the basis for designing a social learning process to build knowledge, comprehension and communication regarding possible alternative solutions to problems identified by the SRF. This involved: the SL methodology. Structural analysis (Godet, 2001) of problems identified during community workshops with the objective of prioritizing and evaluating sustainable land management alternatives (Smith and Dumanski (1993).

This study offers a new proposal based on social learning and other processes developed in Cuba by Sosa *et al.* (2011) during the so-called agroecological revolution. The alternatives selected in the stage prior to evaluating their sustainability would have to be carried out during a process of agricultural innovation-experimentation and communication in order to promote functional and structural changes on the family unit and community levels.

Systematizing and information analysis: Information was obtained through participatory workshops including a variety of activities and by applying 27 interviews to key informants. Data were transcribed and tables describing the results were drawn up. In some cases, qualitative information was described according to workshop participant's interpretations of the topics analyzed, following the process described in the community planning manual by Parra *et al.* (2011).

RESULTS AND DISCUSSION

History of the region: The region's history has involved a political process by which a variety of individuals and organizations have contributed to the current importance of the region's livestock raising for Granma Province and the nation as a whole. The historic changes are summarized in five stages described in Table 3.

Current stage (2008 to the present): In 2008 the Cuban government initiated a process of granting idle lands in usufruct to those interested in producing food (Ruz, 2008). Usufruct farmers, together with small-scale land-owning farmers, form the Credit and Services Cooperatives (CCS). Currently in the Cauto Valley, 167,101 ha of land is used for livestock raising by four large-scale livestock businesses, 20 state farms, 40 UBPC, 17 Agricultural Production Cooperatives (CPA) and 14 CCS. Of the total land area devoted to livestock, 64,120 ha are covered by naturalized grasses, 33,420 ha with fodder and cultivated grass and 60,880 ha with weeds and secondary or invasive vegetation such as marabu (Benitez, 2003; Fajardo, 2009).

Vulnerability: Two types of vulnerability affect farm families. One is caused by factors inherent to the household such as family composition and factors which condition access to resources, including economic activity and educational level. The other is caused by factors external to the household which are not controlled by the family these may be divided into tendencies and shocks. Tendencies are related to macroeconomic policies and changes in international prices and shocks with catastrophes caused by natural phenomena such as floods, droughts, pests and diseases (Pat-Fernandez, 2010).

Vulnerability on a regional scale is related to factors external to the households such as the market, natural disasters and the economic blockade imposed by the US government on Cuba through US Presidential Decree 3477, since, 1960.

Economic blockade: The economic blockade on Cuba is a vulnerability factor for families in the region. This measure originated as a response to the Cuban government's expropriation of North American sugar companies and haciendas in Cuba (Triana, 1997), since, 1960 all direct commercial relations between Cuba and the United States or through third party nations have been prohibited. With the blockade, Cuba lost 60% of those exports which they carried out in 1959 as well as imports

Table 3: Characteristics of the stages of the history of the Cauto Valley, Granma, Cuba

Stages	Characteristics
Settlement (1492-1701)	Settlement of the region was a long process. The first people inhabiting these lands were the aboriginal tribes (Ciboneyes and Tainos) who migrated over 10,000 years ago from the Bahamas, later from the Mississipi and Florida regions and still later from Venezuela and Central America (Torres-Cuevas and Loyola, 2002). The villa San Salvador de Bayamo was founded in 1513 (Guerra and Loyola, 2012). During the 16th century, people of San Salvador de Bayamo migrated north of Bayamo, founding the village Cauto Cristo in 1650 and the village Jiguani in 1701 (Castro-Medel, 2010)
Economic growth (1530-1959)	Livestock raising is the region's most important economic activity, dating back to 1530 according to Leyva (2011). A relatively diversified crop agriculture for local sale grew in importance. Agriculture was based on haciendas in the colonial stage and in 1959 began to be transformed into large-scale businesses, state farms and small-scale family farms. During this stage, 60 state farms and nine large-scale agricultural businesses were established in the region
Agricultural maturity (1960-1989)	Cuba adopted the global tendency to increase productivity through large-scale agriculture using machinery and agrochemicals, based on the GreenRevolution agricultural modernization model, involving high use of external inputs with great environmental costs. In1982, farmers of the region were collectively organized into 17 Agricultural Production Cooperatives (CPA according to the Spanish initials) and 14 Credit and Service Cooperatives (CCS according to the Spanish initials) the latter of which were formed to incorporate farmers who wished to continue to produce on their land in an individual manner. This stage was characterized by big-business agriculture with high use of external inputs. Meanwhile, 75% of the rural population migrated to urban areas (Funes-Monzote, 2009)
Agricultural collapse (1990-1993)	The 1990 economic crisis prevented importation of external inputs, provoking the demise of the agricultural system. With this, Cuba's dependence on external inputs-resulting in food insecurity-became evident. This stage was characterized by soil erosion, groundwater contamination and deforestation as a consequence of indiscriminant agrochemical use during the previous stage. The need to promote organic agriculture thus became apparent
Agricultural renovation (1994-present)	As a result of necessity, the system's potential to make way for creativity and innovation was liberated. Forty state farms were converted into UBPCs. The region generally underwent a transition from the existing agricultural system to sustainable agriculture, given the need to substitute external chemical inputs with biological inputs. This process has been guided by organic agriculture and agroecology practices (Funes-Monzote, 2006). Farmers have developed innovative methods and technologies for adapting their agricultural systems to the limited availability of resources and inputs with an emphasis on environmental protection and agricultural diversity (Guevara Hernandez *et al*., 2011; Ortiz *et al*., 2012). During this stage, many people who had migrated to cities have returned to rural areas

of US agricultural inputs and technologies (Reyes-Bernal, 2008). This aspect in particular has propitiated Cuba's tendency in recent years of transforming high-input agriculture into organic and agroecological agriculture by which farmers have made up for the lack of agricultural inputs with innovations based on agroecological and organic production principles, not only for economic reasons but also with environmental and social motives (Montes, 2004).

According to Reyes-Bernal (2008) farmers lack access to government support and programs necessary for improving economic conditions. This is due to the fact that Cuba cannot sell its agricultural products or other products such as nickel and cobalt on the international market. The blockade impedes the Cuban government, namely the Ministry of Agriculture from having sufficient funds to establish and finance programs to support or invest in its farmers. Cuban farmers were accustomed to using US rice, corn and bean seed but, since, the blockade, Cuba has had to purchase seed from farther away nations and farmers have had to produce their own seed. According to the Communications Director of the Ministry of Agricultural, damage from the blockade is manifested in agricultural exports being carried out by third party nations at a greater cost as well as a lack of scientific exchange between Cuban and US institutions.

The global economic crisis is another factor which together with the economic blockade, places producers and farm families at a disadvantage, drastically reducing the Cuban government`s possibilities of funding programs which could augment familie's physical capital and support their livelihood strategies.

Markets: Workshop participants named the market as a vulnerability factor for their families. Government market policies establish that the CPA and CCS must establish marketing contracts for the farmer's products which are not always satisfactory as the government wholesale purchaser often faces difficulty in transporting the products to markets which are generally located in the municipal seats.

The government wholesale purchaser often does not comply with commitments established with the farmers who thus, lose money from their harvests. Market policy does not establish any form of reparations for farmers in case of noncompliance of contracts by the wholesale purchaser. Farmers argue that if they had nearby markets they could more easily sell their products, thus, obtaining income at the point of sale. According to one form of marketing which proved beneficial to farmers but ended in 2003 after selling a portion of their products to the wholesale purchaser at state established prices, farmers could sell their remaining products directly in the state agricultural markets, receiving higher pre-established prices. Another form of marketing which benefitted producers but which ended in 2004 was the supply and demand market by which prices were established between the buyer and the seller (Arias and Mendoza, 2011).

According to Gonzalez with respect to marketing of agricultural products, contradictions exist between existing legislation, jurisprudence and marketing practices. However, policies for marketing farm products to the tourist industry have been modified, for example in 2011 the government authorized farmers to directly sell their products to hotels.

Natural disasters: Natural disasters are another vulnerability factor for families; workshop participants spoke of prolonged droughts in the region. Quintana and Alvarez state that in recent decades droughts have become increasingly prolonged and intense droughts have occurred every 2 years. Furthermore, unequal distribution of rain throughout the year affects crops and livestock. For this reason, families of the community La Concepcion, for example, consider hurricanes to often be beneficial as the increased rain leads to better harvests and better quality pastures.

Nevertheless, global climate change is a threat to family farm systems in Cuba. Centella *et al.* (2006) point out in recent decades, an increase in minimum temperature of up to 0.6°C that the date that minimum temperatures rise above 20°C is increasingly earlier; a decrease in thermic oscillation an increase in the destructive power of severe storms and greater frequency of precipitation. The intensity of effects of anticylones has also varied with unpredictable consequences on precipitation in Cuba.

Description and analysis of livelihoods of Cauto Valley families: The description of Livelihoods of SRF in the Cauto Valley shows that PA, PU and UBPC workers share values with respect to patriotism, creed, respect, solidarity, self-esteem, fidelity and the family as basis of society.

The Federation of Cuban Women (FMC) (A civic organization which unites all Cuban women with groups in all communities) has promoted equity between women and men on a national level with concrete impacts on structural aspects which reproduce gender inequality in Cuba. Cuban women do not face marginalization and women and men have the same opportunities to work, receive an education and be elected to positions in government and civic organizations.

In the UBPC, women have the same opportunities as men to work and decide how to spend their earnings. Furthermore, the UBPC administrations contribute to the

fact that increasingly more men and women are conscious of gender equity and equality given that they avoid sexist division in the workplace and offer opportunities to women who are not employees of the UBPC. For example, in the UBPC Papi Lastre, a community project with a gender focus has provided the opportunity for 14 local women who are not permanent employees to participate in the UBPC with their backyard harvest.

In the case of the PA and PU, isolated families do not value gender equity. By contrast in the community La Concepcion, women's and men's participation in environmental projects has been based on equal conditions and opportunities. Also, many women work the land along with men for example making decisions and managing backyard animals and sheep.

Religious beliefs are irrespective of form of land tenancy. Some farmers believe in spiritism, others in Santeria and more recently others in Pentecostalism.

Analysis of capitals: For Bourdieu capitals are resources used to increase familie's incomes and are invested to obtain benefits. For this reason they are referred to as capitals.

Human capital: Human capital including knowledge and abilities is critical to maximizing the combined benefit of the other capitals. Furthermore, this capital is important to carrying out a strategy for change because abilities and knowledge are needed to undertake a strategy which allows for economic growth (Elliot, 2008). In the rural areas of the Cauto Valley, families Practice Agriculture on their own land (PA) on land in Usufruct (PU) or in backyards or on marginal land (UBPC workers). Labor is typically carried out by family members who principally possess traditional knowledge and acquired technical knowledge.

Workers and retired members of the UBPC have technical knowledge of cattle, sheep and goat raising which they have acquired through training by their UBPC and participation in workshops and courses by Granma University, IIAJD and farmer's associations such as the Cuban Animal Production Association. Farmers interviewed have a formal education level ranging from primary school to university training in agriculture. Members of the UBPC Raul Sánchez have knowledge of and produce, coal.

The PA interviewed have a primary and secondary educational level and to a lesser extent university training and have generally inherited their parent's land and possess traditional knowledge in raising sheep, cattle and crops such as maize, tubers and bananas. Furthermore, they have technical knowledge acquired through training by their CCS and in workshops, courses and fairs organized by scientific institutions.

The PU possess professional knowledge as teachers, technical advisors and engineers, aside from technical knowledge from training received through their CCS or other farmer's organizations, workshops, courses and fairs organized by scientific institutions. Illiteracy is absent in all three forms of land tenancy. Educational level is closely related to financial capital due to the fact that farmers with a greater formal educational level have greater possibilities of more efficiently managing their farm (Van der Sluis *et al*., 2005).

According to Kabir *et al*. (2012) farmer age is closely related to financial capital. Younger farmers are more active and willing to participate in farm activities and have a greater tendency to experiment, allowing them to more easily access credit or financing by NGOs. This significantly impacts small and medium-scale farms and eventually contributes to familie's financial capital.

In the UBPC, workers range in age from 18-65 but retired workers continue to produce in their backyards. Workers under the land tenancy forms PA and PU range in age from 43 and 78 with an average age of 65. The topic of training ("formation") in developing and carrying out agricultural and environmental projects was addressed by workshop participants in the three UBPC; only those of Papi Lastre said to have undertaken community projects. In the case of the PA, only farmers of the community La Concepcion have experience in carrying out projects as beneficiaries of a United Nations Small Donations Program of the fund for the World Environment project to develop a natural resource management program. Of the PU, only one farmer of the community Santa Maria has been benefited by projects for producing sheep meat for people with anemia, financed by the public health ministry. The other PU have not been benefitted by projects as they lack the training and experience which could lead them in this way to improve their farm systems and thereby their familie's standard of living.

Social capital: According to Hintze social capital is the sum of institutions, relationships and norms which make up society. Taking this into account, the region's communities possess a great deal of organizational capacity. The communities are represented in the municipalities by neighborhood representatives and by the president of the popular council an association which coordinates the activities of various organizations in the communities (Noguera, 2006). In 2000, Law 92 gave provincial assemblies the power of creating the popular councils, once these are proposed by the municipal assemblies.

The popular council consists of a president and several neighborhood representatives. Each popular council is a space for neighborhood citizens to discuss and

debate local development plans and proposals which they have made in their biannual assembles in which their elected representatives also present their progress in implementing these plans (Ortiz, 2013; Carrillo, 2012).

While the popular council provides an opportunity for community participation, community members often conform with commenting on problems but few make concrete proposals and participate in decision making (Chaguaceda *et al*., 2012).

The Committee for Defense of the Revolution (CDR) is a civic organization in which community members debate and participate in local matters. All citizens over 14 years of age participate. The CDR meets monthly to coordinate activities such as population censes vaccines and efforts to control dengue and other illnesses. Furthermore, it organizes patriotic and cultural events which reinforce community values.

Women and girls over 14 belong to the FMC which educates them regarding their rights and obligations and other topics related to gender including equal opportunities. This organization provides an opportunity for women to actively participate in community improvement efforts and together with the CDRs, the FMC works to control epidemics and organize social and cultural activities for women and their families in order to promote family and community harmony.

The PA and PU are organized within the CCSs which belong to the National Association of Small Farmers (ANAP) which plays an important role within the communities. Within the CCS, decisions related to production and marketing are made and the CCS assist the farmers with agricultural and marketing issues. Farmers should inform the CCS as to what they plan to produce and the CCS establishes contracts with the PU and PA to purchase a portion of their products. Each farmer makes sale contracts through the CCS and the sale itself is carried out through an intermediary or government wholesale purchaser. The CCS also addresses matters related to access to resources (land, tools, machinery) as it has access to higher level government bodies (Agriculture Department, ANAP). The CCS and ANAP also control access to agricultural innovation projects thus for a community project to be developed it must be approved by ANAP and the CCS.

UBPC workers interact in a different manner with the CCS than do the PA and PU. UBPC workers receive a monthly salary and typically sell their backyard produce directly to consumers, although, they may establish contracts with the UBPC administration to sell their products.

Farmers also deal with other organizations such as the small livestock business which establishes contracts with some sheep and goat producers for sale and purchase of animals. The provincial agriculture department makes all decisions related to agricultural legislation (inheritance, usufruct, marketing, prices, etc.).

Farmer's networks with social capital are valuable resources as they facilitate or block their economic activities and facilitate access to opportunities which benefit their livelihood strategies (Abreu *et al*., 2010).

Families possess an additional type of social capital related to prestige, morale and respect won over time by virtue of their interactions within their community. This capital allows them to elect and be elected as neighborhood representatives of their community in the municipal assembly with the power to solicit community services and infrastructure from their popular council and seek positions (president, vice-president and administrator) within the CCS and in other community organizations (CDR, FMC).

Natural capital: Agricultural processes and yield strongly depend on the state of the region's natural capital. Natural capital in the three types of land tenancy consists of land, soil, natural vegetation, water (including precipitation) livestock raising (sheep and cattle) and crop agriculture. Many soils are affected by erosion, salinity and groundwater contamination as a consequence of indiscriminant agrochemical use during the green revolution. Generally, no soil restoration is carried out with the exception of the PA of in community La Concepción who have established drainage for rainwater infiltration and use of green manures.

Productivity of livestock (sheep and cattle) under all forms of land tenancy in the region is low due to management deficiencies, parasites and the fact that feeding depends on natural vegetation. In the region, 78% of grasses are wild (*Dichanthium caricosum*, *Dichanthium annulatum*) (Benitez, 2003) characterized by low nutritional quality. Furthermore, all farmers expect scarcity of grasses during the dry season.

The CCS governed by Agricultural Ministry legislation controls access to land through Decree 125 (for PA) and Decree 300 (for PU). Thus, access to natural capital depends on access to human and social capital, due to the need for knowledge, abilities and relationships or alliances with the government to obtain land from which to develop a livelihood strategy.

Physical capital: Physical capital (Table 4) refers to services to which families have access as well as community and agricultural infrastructure. The community with the least services is La Concepcion, lacking schools, electricity and running water; inhabitants must travel to another community for these services. It also lacks public transportation and the road is in a very

Table 4: Physical capital of the communities studied in the Cauto Valley, Granma, Cuba

Communities	Health services	Running water	Sewage system	Electricity	Education	Public transportation	Roads	Tools
PA La Concepcion	No	No	PitLatrine	No	No	No	Path	Manual
PA Cautillo	Medical clinic	Yes	Pit latrine	Yes	Primary	No	Highway Dirt road	Manual
PA Cauto Cristo Oeste	Medical clinic	Yes	Pit Latrine	Yes	Primary secondary high school	Yes	Highway	Manual and tractor
PU Santa Maria	Medical clinic	Well water	Pit Latrine	Yes	Primary	No	Highway Dirt road	Manual
PU Cautillo Merendero	Medical clinic	Yes	PitLatrine	Yes	Primary secondary	No	Highway	Manual
PU Cauto Oeste	Medical clinic	Yes	Pit Latrine	Yes	Primary secondary high school	Yes	Highway	Manual
UBPC Papi Lastre	Medical clinic	No	Pit Latrine	Yes	Primary	No	Dirt road	
UBPC Raul Sanchez	Medical clinic	Yes	Pit Latrine	Yes	Primary secondary high school	Yes	Highway	Few manual
UBPC Batalla Peralejo	Medical clinic	Deficient	Pit Latrine	Yes	Primary secondary	No	Highway	Manual

Table 5: Income and expenses of families in the communities studied in the Cauto Valley, Granma, Cuba

Form of land tenancy	Annual income	Annual expenses	Balance
UBPC Papi Lastre	$18,119.00 (724.76 UDS)	$15,890.00 (635.60 USD)	$2,229.00 (89.16 USD)
UBPC Raul Sanchez	15,261.00 (610.44 USD)	$12,960.00 (518.40 USD)	$2,301.00 (92.04 USD)
UBPC Batalla de Peralejo	$13,300.00 (532.00. USD)	12,360.00 (494.40 USD)	$940.00 (37.60 USD)
La Concepcion	$15,800.00 (632.00 USD)	$8,300.00 (332.00 USD)	$7,500.00 (300 USD)
Cauto Cristo Oeste	$23,800.00 (952.00 USD)	$11,950.00 (478.00 USD)	$11,850.00 (474.00 USD)
Cautillo	$25,700.00 (1,028.00 USD)	$8,610.00 (344.40 USD)	$17,090.00 (683.60 USD)
Santa Maria	$21,980.00 (879.20 USD)	$9,100.00 (364.00 USD)	$12,880.00 (515.20 USD)
Cauto Oeste	$19,500.00 (780.00 USD)	$10,300.00 (412.00 USD)	$9, 200.00 (368.00 USD)
Cautillo Merendero	$21,000.00 (840.00 USD)	$9,400.00 (376.00 USD)	$11,600.00 (464.00 USD)

poor state. Means of communication are limited to one public telephone; there is no postal service. Farmers have only manual farm tools and teams of oxen. The remaining communities have primary schools and medical clinics. Secondary schools are present only in the communities Cauto Cristo Oeste, Cauto Oeste, Cautillo Merendero and in the communities of the UBPCs Raul Sanchez and Batalla de Peralejo. High schools only exist in the communities Cauto Cristo Oeste, Cauto Oeste and in the community of the UBPC Raul Sanchez.

Only the communities Cauto Cristo Oeste, Cauto Oeste and the community of the UBPC Raul Sanchez have their own public transportation terminals. Inhabitants of the remaining communities, lacking their own vehicles, may ride in vehicles which travel to the municipal seats of Jiguani, Bayamo and Cauto Cristo and stop in other communities. With respect to farm tools, farmer's yields are limited as they lack many necessary tools.

The principal problems of the rural communities are due to insufficient services. Barranco-Rodriguez (1998) states that 64.6% of Cauto Valley homes are in average or poor condition only 34% of settlements have electricity; 55.4% of the population has running water and 173 communities lack sufficient water. With respect to rural Cuba as a whole 98% of communities use latrines, primary schools are lacking or in poor condition and medical clinics are lacking in some areas. Paved and dirt roads are in very poor condition and postal and telephone services are deficient.

Financial capital: Annual income of the UBPC workers (Table 5) includes wages from labor and income from sale of backyard products. The typical family in the UBPCs Papi Lastre and Batalla de Peralejo has four members and in the UBPC Raul Sanchez, three members.

Income varies as salaries depend on profits obtained by the UBPC and families sell varying quantities of products from their backyards to increase their income.

Annual income of PA and PU families includes salaries of some family members and income from sale of products from their farms. The typical family has two to four members.

Using as a reference the amount of US dollars required to satisfy basic needs on a daily basis, as recognized by international organizations (Chen and Ravallion, 2008) the income of the community La Concepcion and the communities of the UBPCs Papi Lastre, Raul Sanchez and Batalla de Peralejo are below the poverty line.

Table 6: Family strategies under three forms of land tenancy in the Cauto Valley, Granma, Cuba

Strategy		
UBPC	PA	PU
Labor-Agricultural	Agricultural-Labor	Agricultural-Labor
Wage labor	Wage labor	Wage labor
Backyard animals-sale and consumption	Backyard animals-sale and consumption	Backyard animals-sale and consumption
Sheep-sale and consumption	Sheep-sale and consumption	Sheep-sale and consumption
Sale of firewood and coal	Sale of cattle	Milk-sale and consumption
Loans	Milk-sale and consumption	Crops-sale and consumption
Family remittances	Crops-sale and consumption Loans	

Table 7: Percentage contribution of different economic activities to families total annual income in the Cauto Valley, Granma, Cuba

Contribution to income (%)	UBPC papi lastre	UBPC raul sanchez	UBPC batalla de peralejos	PA la concepcion	PA cauto cristo Oeste	PA cautillo	PU santa maria	PU cauto oeste	PU cautillo merendero
Wage labor	34.6	28.7	39.0	-	16.8	18.7	28.6	21.5	21.9
Cattle raising	-	-	-	44.6	23.2	20.6	15.8	20.5	11.9
Backyard animals	30.6	26.2	36.6	32.7	6.3	7.8	6.8	7.7	10.9
Sheep raising	16.0	6.6	24.4	4.9	16.8	7.8	18.9	10.3	9.5
Crop agriculture	-	-	-	11.9	36.9	45.1	45.6	40.0	45.8
Firewood and coal	-	38.5	-	-	-	-	-	-	-
Loans	5.4	-	-	5.9	-	-	-	-	-
Remittances	13.4	-	-	-	-	-	-	-	-

The PA tend to save in case of a poor harvest due to drought or hurricanes. The PU tend to save also due to potentially adverse conditions but as they possess the land in usufruct for a determined period of time, many hope to improve their living standard during this period. The UBPC workers do not tend to save, perhaps due to the fact that they can expect a fixed monthly salary.

Family livelihood strategies: All families carry out several activities to supplement their income (Table 6). UBPC workers receive a salary for their work, aside from sale of backyard production which allows them to increase their income and directly feed their families. Thus, their strategy is principally labor-related, supplemented by agriculture. With respect to the PA and PU family strategy, agriculture provides the basis of their income which is supplemented by some family members seeking wage employment.

Diversifying livelihood strategies through various activities is very important, above all to confront natural disasters and mitigate climate change (Rios *et al*., 2011). In Mexico, Ramos *et al.* (2009) state that food production no longer met local self-sufficiency in the municipality of Oxchuc, Chiapas and as a response farmers diversified their production strategies with youth and adults migrating in search of better living conditions.

Livelihood outcomes: The combination of the capitals leads to livelihood strategies which in turn result in livelihoods. Agriculture is strongly affected by the situation of the capitals in the different communities (scarcity of water for domestic use and irrigation, prolonged droughts, lack of tools, eroded soils, degraded natural vegetation, insufficient income, lack of government support and rigid marketing organizations and policies). Ironically, this contributes to diversification of agriculture, thus, obtaining various products and maximizing synergies between crop agriculture and livestock raising with few inputs, effectively oriented toward organic production. According to La (2013), the typologies of different families agricultural systems are heterogenous due to differences in income, family size, agricultural infrastructure of each sub-region, the relative contribution of agricultural production and wage labor to total family income and access to markets.

In relation to annual income presented in the section on financial capital, the contribution of different activities carried out by the families to total annual income varies (Table 7). The majority of income of UBPC Raul Sanchez workers comes from wage labor, backyard animals, firewood and coal while the majority of the PA's income comes from agriculture and cattle and that of the PU from agriculture and wage labor. The economic contribution of sheep to the incomes of families of all types of land tenancy is low.

Problems in the Cauto Valley: In the community workshops, participants mentioned a need to improve soil conditions, collect and store rainwater, increase livestock productivity and agricultural yields, improve marketing and acquire farm tools. They also pointed out the need to improve roads, transportation, water availability and community services (medical clinics, schools and markets) increase salaries of household members working off the farm and carry out community projects such as natural resource management, reforestation and establishment of silvopastoral systems.

Table 8 and 9 show the matrices of motricity and dependence for those problems identified by workshop participants. Figures 1 and 2 show a Cartesian plane of

Table 8: Matrix of influence and dependence of the problems of small-scale land-owning farmers and usufruct producers in the Cauto Valley, Granma, Cuba

	1	2	3	4	5	6	7	8	9	10	11	12	Influence	Motricity index
Access roads in poor state	0	2	2	1	0	0	0	0	3	0	0	1	9	7.8
Deficient public transportation	0	0	3	0	0	0	0	0	3	0	0	1	7	6.1
Deficient community services	1	1	0	2	0	0	0	0	0	0	0	0	4	3.5
Water scarcity	0	0	3	0	0	0	0	0	0	0	3	2	8	7.0
Lack of work tools	0	0	0	1	0	0	0	0	0	0	3	3	7	6.1
Environmental contamination	0	0	0	2	0	0	3	3	0	3	3	3	17	14.9
Soil degradation	0	0	0	0	0	1	0	3	0	0	3	3	10	8.8
Deforestation	0	0	0	3	0	3	3	0	0	3	3	3	18	15.8
Market difficulties	0	0	0	0	2	0	0	0	0	0	2	3	7	6.1
Disturbed natural vegetation	0	0	0	2	0	3	3	3	0	0	3	3	17	14.9
Low sheep productivity	0	0	0	0	1	0	0	0	0	0	0	3	4	3.5
Low income	0	0	0	1	3	0	0	1	0	1	0	0	6	5.2
Dependence	1	3	8	12	6	7	9	10	6	7	20	25	114	
Dependence index	0.9	2.6	7.0	10.5	5.2	6.1	7.8	8.8	5.2	6.1	17.5	21.9		

Table 9: Matrix of influence and dependence of the problems of Basic Units of Cooperative Production (UBPC) workers in the Cauto Valley, Granma, Cuba

Variables	1	2	3	4	5	6	7	Influence	Motricity index
Deficient transportation	0	1	0	0	0	0	2	3	5.5
Water scarcity	0	0	0	1	1	1	3	6	10.9
Environmental contamination	0	3	0	3	1	2	3	12	21.8
Soil degradation	0	2	1	0	1	3	3	10	18.2
Deforestation	0	3	3	3	0	2	3	14	25.4
Disturbed natural vegetation	0	1	1	1	1	0	3	7	12.7
Low income	0	1	0	0	1	1	0	3	5.5
Dependence	0	11	5	8	5	9	17	55	
Dependence Index	0	20.0	9.1	14.5	9.1	16.3	30.9		

four zones which group problems according to their motricity and dependence. Of the twelve problems identified, those of greater influence or motricity for the PA and PU according to the motricity index (Table 8 and Fig. 1) are: Environmental Contamination (EnvC), Deforestation (Deforest) and Disturbed Natural Vegetation (DVegNat) while the problems with the greatest dependence are: Low Incomes (LoInc) and Low Sheep Productivity (LoSP). For the UBPC, the most influential problems according to the motricity index (Table 9 and Fig. 2) are: Deforestation (Deforest), Environmental Contamination (EnvC) and Soil Degradation (SoDeg) while the problems with the greatest dependence are: Low Incomes (LoInc), Disturbed Natural Vegetation (DVegNat) and Water Scarcity (WaSc).

Priority problems those with the greatest motricity are clearly located in the zone of power (Fig. 1 and 2). These problems have a high influence and low dependence on the remaining problems. Thus, they could catalyze or break down the system. Resolving these problems favors system sustainability. Those problems with the greatest motricity should be attended to with priority due to their implications on the family farm systems. Problems located in the zones of exit and results are highly dependent on other problems. Therefore, it is not urgent to try to resolve them as they will resolve themselves when the motricity problems are resolved.

Of those problems located in the zone of power, the region was severely impacted by indiscriminant deforestation by the timber industry and to clear the land for crop agriculture and livestock raising during the green revolution (Benitez, 2003). Currently, deforestation influences the majority of the region's problems, especially, environmental contamination. Deforestation also leads to disturbed natural vegetation, soil degradation and water scarcity caused by low precipitation and prolonged droughts which alter the water cycle (Vuelta-Lorenzo, 2011).

Soil degradation also greatly affects the Cauto Valley communities; the soil was severely degraded and contaminated during the green revolution, due to intensive land use and application of agrochemicals. Currently, soils show damage due to compaction, poor drainage, agrochemical residues and fertility loss (Funes-Monzote, 2006).

Evaluation of alternatives: Table 10 characterizes alternatives that workshop participants (farmers and researchers) evaluated and selected to achieve sustainable land management as they are sustainable and may viably be put into practice in the communities. Individual and collective efforts of farmers of the three types of land tenancy (PA, PU, UBPC) to implement these alternatives could contribute to reverting the region's current situation.

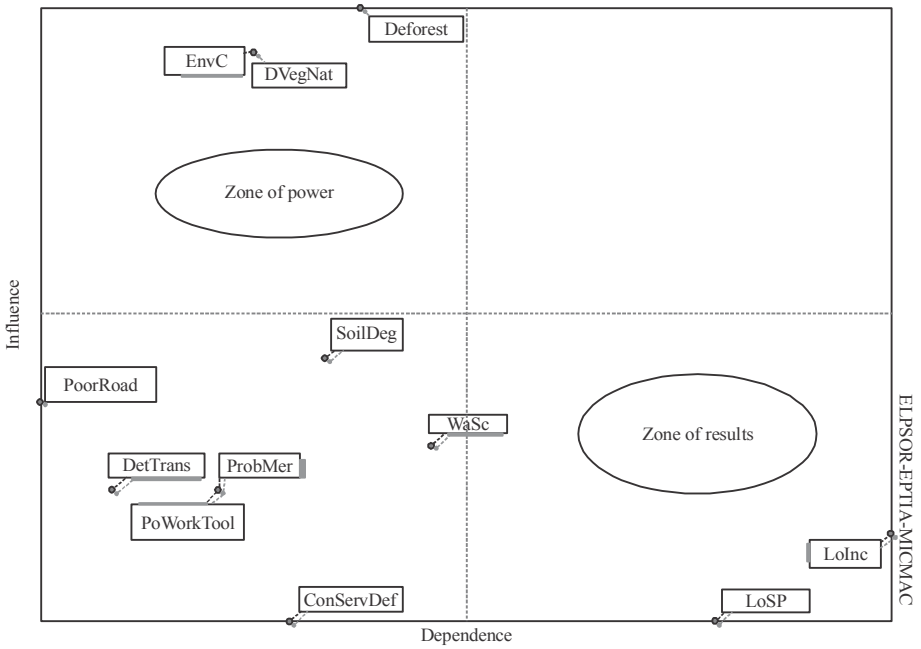

Fig. 1: Cartesian plane with four zones grouping problems of small-scale landowning farmers and usufruct producers according to their motricity and dependence for the Cauto Valley, Granma, Cuba

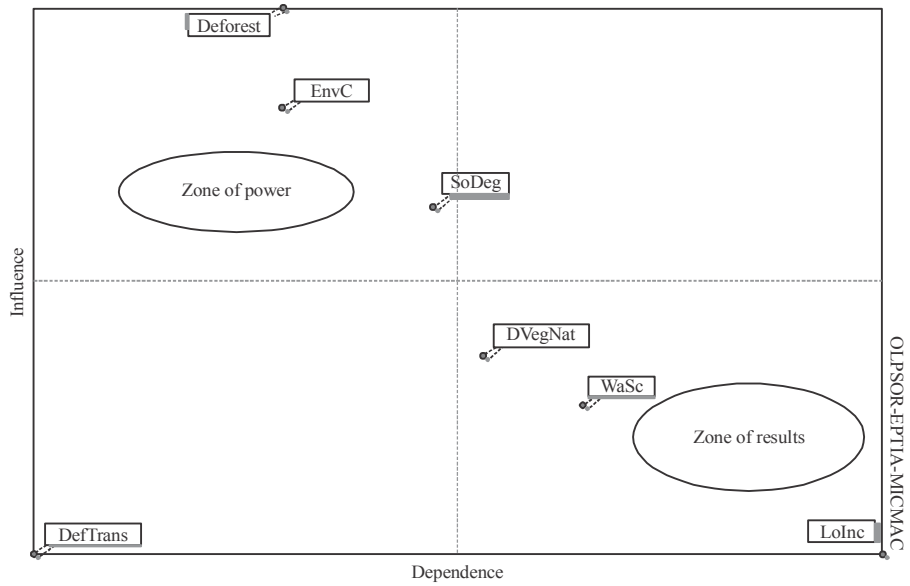

Fig. 2: Cartesian plane with the four zones grouping problems of the Basic Units of Cooperative Production workers according to their motricity and dependence for the Cauto Valley, Granma, Cuba

These practices will result in resolution of the problems shown in the zone of exit of the structural analysis (Fig. 1 and 2). With this, the region may increase productivity of sheep and cattle and improve vegetation used as livestock feed which also serves to fertilize the soil. All this could result in families increased annual income and well-being.

Figure 3 shows the results of the evaluation of the five alternatives selected, with the six pillars of sustainable land management showing similar behavior for all five alternatives; farmers decided that the five may viably be applied in the region. Green manures help address soil contamination and lack of fertility and their application in maize has allowed for increasing yields

Table 10: Characterization of possible alternatives selected by workshop participants for sustainable land management in the communities of the Cauto Valley, Granma, Cuba

Production system/Problems	Alternatives	Advantages of the alternative	Beneficiaries of the alternative
Crop agriculture	Agroecological soil restoration	Greater fertility and productio	PA, PU, UBPC
Soil degradation			
Environmental contamination	Use of green manure	Greater fertility	
		Availability of plant matter	
		Greater productivity	
Cattle raisin			
Deforestation	Community reforestation	Recovery of locally adapted	PA, PU
Environmental contamination		plant and animal species	
Disturbed natural vegetation	Reforestation of grazing area	Svailability of food and shade	
		for livestock	
	Silvopastoral system	Reduced soil erosion	
		Cleaner production	
	Organic livestock raising	Qualilty and safety of	
		animal products	
Sheep raisin			
Deforestation	Community reforestation	Recovery of locally adapted	PA, PU, UBPC
Environmental contamination		plant and animal species	
Disturbed natural vegetation	Silvopastoral system	Availability of food and shade	
		for livestock	
	Organic livestock raising	Reduced soil erosion	
		Cleaner production	
		Qualilty and safety of animal products	

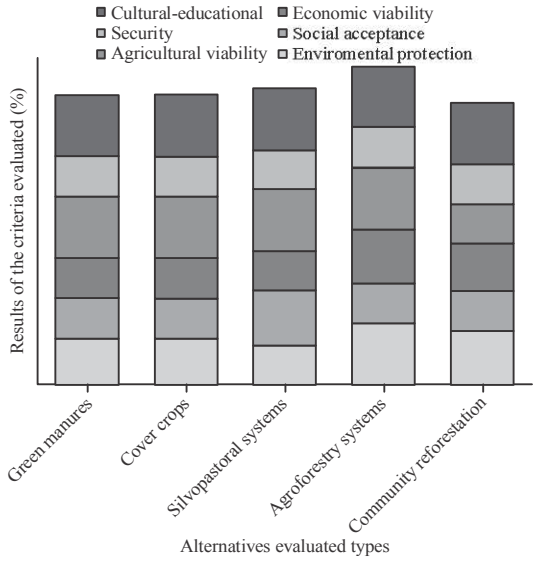

Fig. 3: Evaluation of the sustainability of five alternatives selected by workshop participants in communities of the Cauto Valley, Granma, Cuba

(Garcia *et al*., 2002). Cover crops also contribute to reducing soil degradation and their use has had positive results for yucca, maize and beans in the Cuyaguateje River watershed in Cuba (Leal *et al*., 2007). Silvopastoral and agroforestry systems in Cuba have advantages over pasture systems without trees as they contribute to resolving the marked seasonality of natural grass production given that trees and shrubs produce large quantities of biomass even under conditions of zero fertilization and drought and the nutritional content of the foliage is greater than that of natural grasses. Thus, animal production is increased (Iglesias and Giraldo, 2011). Community reforestation helps communities resolve severe soil erosion as well as problems related to the water cycle (PFACRMS., 2008).

Social learning: The social learning model of innovation is conceived within agricultural development as socially constructed knowledge which is a product of collective learning (Rodriguez *et al*., 2009). Putting into practice this model through processes and strategies oriented toward farm families innovation and experimentation catalyzes annual cycles of individual and collective learning which culminate with analysis of lessons learned by the communities in each stage of the process.

The upper part of Fig. 4 shows the different levels of decision maker's role in Cuban agriculture and the lower part shows the steps in establishing proposals for sustainable alternatives. These alternatives would have to be put into practice under a scheme of innovation, experimentation, learning, knowledge construction and exchange and communication of experiences throughout the different levels of decision making in Cuban agriculture. This is the case of the Program for Local Agricultural Innovation (PIAL), already implemented in several parts of the country (Ortiz *et al*., 2012).

The process should be developed in a continuous manner, incorporating lessons learned at each stage in order to generate new knowledge which should in turn be put into practice continually through agricultural innovation and experimentation, giving way to a new family production scenario. Once a new scenario has been achieved, public servants (decision makers) of the different levels of government should receive feedback so that structural changes may be institutionalized through agricultural policies oriented toward sustainable family production.

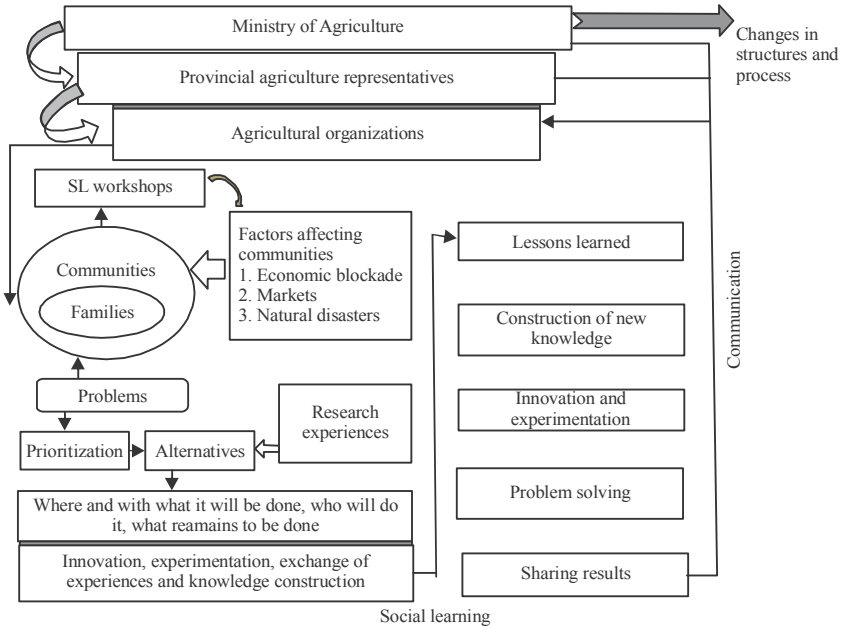

Fig. 4: Scheme of social learning to respond to the problems related to levelihoods through a participatory agricultural innovation and experimentation process in the Cauto Valley, Granma, Cuba

Resources available to the PA, PU and UBPC workers for putting the alternatives into practice are land a vast organizational capacity an ability to learn and experiences and capabilities to respond to shocks and tendencies, demonstrated in the 1990s during Cuba's greatest agricultural crisis. Nevertheless, the families would need advisory and training in sustainable alternatives (to be assumed by the IIAJD) investment, infrastructure, work tools and seeds of locally adapted tree and shrub species to establish silvopastoral systems and other agroforestry systems.

Work would be carried out by the families and the communitie's social capital (civic organizations, popular Councils, CCS). This process should proceed according to a plan which includes: organization of work (identification of areas on each farm to establish silvopastoral or agroforestry systems and designation of people for each task) sourcing seeds and inputs; establishment of nurseries and implementation of productive systems; identification of areas with degraded soils; identification of green manure species and use of these in priority areas.

Planning process from the local level: In a social learning process initiated from the local level, people are the center of the problem through their participation their perceptions are incorporated to guide the process. In this manner, technical education, traditional knowledge, human capacity for innovation, experimentation and collective knowledge construction are put to the test. This torrent of information should reach higher levels of decision making, so that, the Agricultural Ministry and the Cuban government in general may perceive the family systems as a strength for guaranteeing food sovereignty which is incompatible with food imports. In this manner, new systematic, solid policies should be developed to ensure inclusive participation of farm families in a local planning process.

Currently, several processes have been developed in Cuba's rural communities, putting into practice elements of community planning. These include the Farmer to Farmer Agroecological Movement, developed in Cuba by Via. Campesina (Rosset *et al*., 2011) during the 1990s economic crisis (Machin *et al*., 2011) as well as PIAL (Montes, 2004; Rios *et al*., 2011; Ortiz *et al*., 2012) which has been developed, since, 2004 and has extended to several provinces of Cuba. This has been possible due to systematic policies oriented toward the communitie's welfare and farmer participation.

CONCLUSION

Livelihoods deployed by families of the Cauto Valley in Granma, Cuba are influenced by their different forms of land ownership. Technological, economic, social and environmental changes which have taken place over the course of the history of Cuban agriculture during the stages of settlement, growth, maturity and collapse and the current stage of renovation through agroecological innovation and organic production have contributed to differentiating families livelihoods.

Families of all three types of land tenancy have ample human and social capital but weak natural, physical and financial capital. The combination of these capitals with their varying economic activities define distinct livelihood strategies which in turn lead to different livelihoods according to the type of land tenancy.

Thus, annual income as a result of financial capital in the UBPC which have a labor-agricultural strategy is 532-724 ($\bar{X} = 628$) US dollars annually; for PA which follow an agricultural-labor strategy, 632-1028 ($\bar{X} = 830$) US dollars annually and for PU which follow an agricultural-labor strategy, 780-879 ($\bar{X} = 829$) US dollars annually. These low incomes are largely determined by vulnerability factors, namely the economic blockade, market problems and natural disasters, all of which condition sustainable agricultural development in Cuba irrespective of land tenancy.

SL analysis of sheep raising families in all forms of land tenancy studied favored identification of problems and construction of a proposal for intervention based on the need for change. The proposal was developed collectively by farmers, researchers and specialists of different areas of agricultural knowledge. Thus, it is based on a community planning and social learning process of evaluation, innovation, agricultural experimentation and communication which remains to be put into practice.

The fundamental limitations found upon applying the SL methodology were related to quantitative information. This information stems from the families participating in the workshops and is based on the supposition that they are typical families which is not necessarily true. The methodology may be enriched by strengthening quantitative variables with individual interviews of each family present in the workshops.

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