Socioecological diagnosis and peri-urban family agriculture typification, with emphasis in the production of peach (*Prunus persica*), in El Jarillo, Venezuela

Diagnóstico socioecológico y tipificación de agricultura familiar periurbana, con énfasis en producción de durazno (*Prunus persica*), en El Jarillo, Venezuela

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Abstract

The objective of this work was to typify and describe, from a socioecological perspective, the agricultural activity of the family farming systems in El Jarillo, Venezuela. A transversal descriptive research was carried out from 2009 to 2016 and mixed methods and tools were used, including ethnographic ones. Twenty-seven family farming systems and 44 indicators were measured and analyzed to describe the main characteristics of the systems. Emphasis was placed on peach production. The indicators were grouped in four categories of analysis: Quality of Life (QL), Social Reproduction of the Family (SRF), Energy Efficiency and Conservation of Natural Resources (EECNR) and Autonomy vis-à-vis the Markets (AM). All indicator were weighted on a scale of 0 to 4. Despite being all systems focused on peach production, the differences were sufficient to identify the four types of production systems (A-D). Most of the farms grouped in type A (68%), and only one farm in type D (4%). Types A and D produce only peach, types B produce peach combined with other crops for sale and types C produce items for self-consumption. The average yield of peach was higher than 140 kg plant-1 crop-1 in the period analyzed for all types, except for type D. All types of farms are using agrochemicals to fertilize, fight pests and diseases, and induce flowering, based on techniques of the green revolution. The categories of QL, SRF and AM turned out to be favorable to sustainability, however, the difficulties encountered in the EECNR limit sustainability. The quality of life standards of the farming families are the product of the high rentability and the moderate economic risk, at the expense of the natural resources.

Keywords

peri-urban family agriculture • peach • typification • socioecological systems • sustainability indicators

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Resumen

El objetivo de este trabajo fue tipificar y describir, desde una perspectiva socioecológica, la actividad agrícola de los sistemas de agricultura familiar en El Jarillo, Venezuela. De 2009 a 2016 se realizó una investigación descriptiva transversal y se utilizaron métodos y herramientas mixtas, incluidos los etnográficos. Se analizaron 27 sistemas agrícolas familiares y seanalizaron 44 indicadores para describir las características principales de los sistemas. Se hizo hincapié en la producción de durazno. Los indicadores se agruparon en cuatro categorías de análisis: Calidad de Vida (QL), Reproducción Social de la Familia (SRF), Eficiencia Energética y Conservación de los Recursos Naturales (EECNR) y Autonomía frente a los Mercados (AM). Todos los indicadores se ponderaron en una escala de 0 a 4. A pesar de estar todos los sistemas centrados en la producción de durazno, las diferencias fueron suficientes para identificar los cuatro tipos de sistemas de producción (A-D). La mayoría de las fincas se agruparon en tipo A (68%) y solo una en tipo D (4%). Los tipos A y D producen solo durazno, las fincas tipo B producen durazno combinado con otros cultivos para la venta y las C producen rubros para autoconsumo. El rendimiento promedio de durazno fue superior a 140 kg plant-1 crop-1 en el período analizado, excepto para el tipo D. Todos los tipos de fincas utilizan agroquímicos para fertilizar, combatir plagas y enfermedades e inducir la floración, al estilo de la revolución verde. Las categorías QL, SRF y AM resultaron favorables para la sostenibilidad, sin embargo, las dificultades encontradas en la EECNR limitan la sostenibilidad. Los estándares de calidad de vida de las familias de agricultores son producto de la alta rentabilidad y el riesgo económico moderado, a expensas de los recursos naturales.

Palabras clave

agricultura familiar periurbana • durazno • tipificación • sistemas socioecológicos • indicadores de sostenibilidad

Introduction

Sustainability science is trying to study agro-systems as if they were socioecological systems, and specifically, it is trying to understand the dynamic character of the interactions between nature and society (5). Research on sustainability assumes the objects of study as systems that integrate to social and ecological systems, known as socioecological system (22).

The socioecological integrations or interactions are relations that are established between these subsystems through different channels. First, through the set of human activities and process that create an impact on the ecological systems, like for example, the production of food; second, through the dynamics of the ecosystems, as the floodings, the climate variations, the changes in seasons, and the transformation of the characteristics of the soil that produce effects on the social systems (9).

The interaction can be material, as the flow of energy and natural resources, money, raw material or people; and not material, as flow of information and knowledge, influence of power, the trust, consumers' expectations, etc. Hence that the analysis of a socioecological system is usually considered ecological, economic, and sociocultural aspects (5, 9, 16).

The peach production system in Venezuela has been of particular interest for the agricultural development programs since 1969 (19). Since then, between fourteen and forty-eight peach varieties from different parts of the world have been introduced and tried. Beyond these initiatives, which have been favored by the national government and the private sector, the producers tried to optimize the agro-productive systems and developed their own varieties. They achieved fourteen national varieties with a high level of acceptance between 1973 and 1995 (27).

The national varieties of peach have been introduced in Colombia. These varieties were developed in two localities that today are, at the same time, the largest producers of peach, La Colonia Tovar and El Jarillo located in the Central Mountain of Venezuela. In the period between 2003 and 2011, the production of peach grew in three key indicators at a national level: 38.4% of cultivated area (between 1,246 and 2,022 ha), 59.4% production (between 16,099 and 39,680 mt year^{-1}) and 34.5 % in the performance across the country (between 12,918 and 19,717 kg ha^{-1}) (4).

El Jarillo, that holds second place in production nationwide, dedicates about 500 hectares to the production of this fruit in systems of peri-urban family agriculture. Despite the importance of this primary activity for El Jarillo and Venezuela, there is no significant research about the long-term productivity of these productive systems within the context of sustainability of complex system (18).

This investigation studies agroproductive systems of farming families, with peach as a main crop, under a system of conventional management based on green revolution techniques. Such farming families have developed in El Jarillo, processes of resistance and adaptation to reach the maximum productivity, reason why there are processes other than the productive one that deserve to be integrated in the conception of the family production systems. Thinking of them in this manner implies recognizing them as complex socio-ecological farming systems (2, 24).

A preliminary version of this work was presented before (25). Then, only the evaluation of the agro-ecological sustainability for the year 2007 was carried out and the ecological, economical, and socio-cultural dimensions were worked on separately. The approach of the research has been expanded to include the results of the study by Silva-Laya *et al.* (2017), in terms of the indicators of energy efficiency and based on the premise of the production of peaches by farming families as complex socioecological systems. The systems are supouse to be able to describe the main characteristics of the multiple interactions within the system, and of them with the environment, and to establish the possible groups based on the detected characteristiscs, just as it is proposed by Merma and Julca (2012).

Based on this context, the objective of this investigation was to typify, as per the socio-productive and the performance characteristics of sustainability indicators, and describe, in a socio-ecological manner, the real situation and its tendencies at a most immediate phenomelogical level of twenty-seven peri-urban family agricultural systems, with emphasis in the production of peach in El Jarillo, Venezuela (period 2009/2016). All this with the intention of reaching an approximation to the inherent complexity of the farms and generate spaces and thought processes with the farming families for the understanding of the problems of unsustainability, essential requirement to decision making.

Materials and Methods

Geographical location

The study took place in El Jarillo, parish located in Miranda State, Bolivarian Republic of Venezuela (figure 1, page 354). Despite being one of the smallest states in Venezuelan, it is the second largest in population, with approximately three million people (17). This characteristic turns it into an important center of commercial, socio-cultural, and political activity.

El Jarillo belongs to the hillsides of the Coastal mountain range (1,200-2,000 m above sea level) with a yearly average temperature of 16.7°C. As for the type of soil, it is characterized by entisols and inceptisols soils, little evolved characteristic of the mountains of the coastal mountain range (10). Therefore, the land use capacity of El Jarillo sets this land in class VIIe and class VIIIe-1s-1 (10), because they are not very deep, with very steep slopes, and a high hydro-erosive potential, it can also have superficial rockiness or stoniness; as well as flat soils with micro-depressions, clayey and poorly drained and flood-prone.

Studies types and techniques

A descriptive observational study was designed. The evaluation instrument was put to the test in a preliminary study that assessed the agro-ecological sustainability of the peach farms in the year 2007 (25).

In that instrument, the indicators for each dimension of agroecology are contemplated in a scale of 0-4, where 0 represents the least favorable sustainability value, 2 is the threshold value, and 4 is the optimum value. In the present work, the information gathering took place in the years 2010, 2012, 2014, and 2016, with the intention of investigating the processes of the previous years, that is, 2009, 2011, 2013, and 2015.

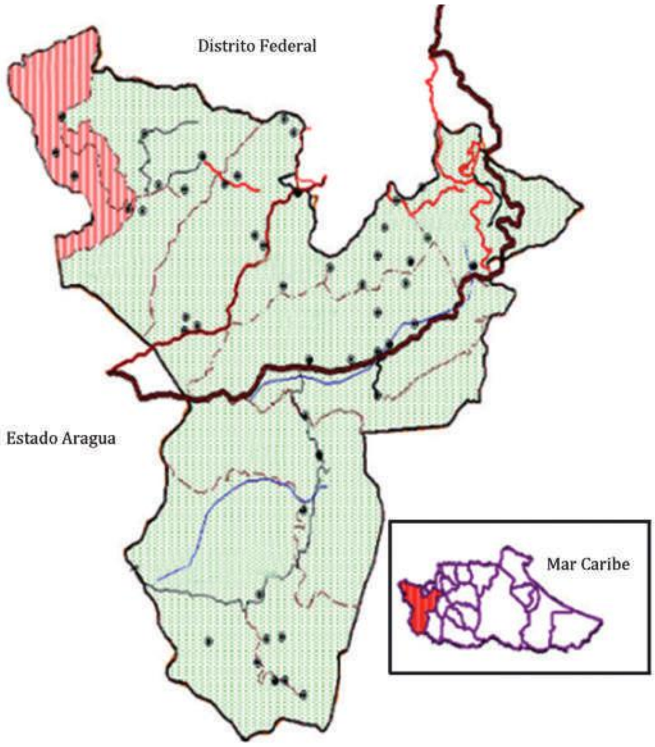


Figure 1. Relative location of El Jarillo parish (striped pink) in Guaicaipuro Municipality (red) inthe Miranda State (green).

Figura 1. Ubicación relativa de la parroquia El Jarillo (rosado rallado) en el municipio Guaicaipuro (rojo) en el estado Miranda (verde).

The same instrument was applied to each of the farms, each year; this way the indicators to issue a final report were considered based on the averages of the years and of the farms, and thus obtain only one result per indicator. Two that changed their productive activity halfway through the study.

Live sources were used and data was collected observing the event its natural context. The 90 farms registered in the Ministry of Agriculture and land by the year 2009 were those considered. From these, with a non-probabilistic or directed sample, twenty-seven farms were chosen for the study. An advantage of this type of sample is its usefulness for particular study designs where it is more important a careful and controlled selection of farms than the representation of the elements of the population.

The diagnosis criteria were determined based on the application of a SWOT matrix (Strengths, Weaknesses, Opportunities, and Threats), as per the methodologies proposed by Astier *et al.* (2011) and Sarandón *et al.* (2014). Once the criteria were determined, four analysis categories were defined in the context of sustainability and thirty-three status indicators to measure (23). These provided information relevant to the situation of the farms for each year of study. The indicators were evaluated in a scale of 0-4 (table 1, page 355-356) as described before (25, 29).

Four key informants of the El Jarillo parish helped with the access to the farming families. Structured interviews were carried out for which a socio-demographic questionnaire was used where they were questions about general information such as age, gender, education level, and family structure.

Likewise, the number of families per productive system, the number of participants, the number of people between 16-60 years of age, the number of hectars, the number of peach plants, kg of peach/plant, the number of total crops, the number of other fruit species, the number of crops used for self-consumption, altitude (m a. s. l.), the number of crops per year, the number of crops for sale, and the supplies needed for production (chemical as well as biological).

Table 1. Description and weighing of indicators per analysis category, in a scale of 0-4.
Tabla 1. Descripción y ponderación de indicadores por categorías de análisis, en la escala 0-4.

Indicator	Standarization of values
Quality of life	
CV1 Housing	(4): Quinta; (2): House; (0): Ranch
CV2 Education	(4): Access to higher education; (2): Access to elementary and high school; (0): With no access to education
CV3 Health	(4): Health Center with permanent doctors and adequate infrastructure; (3): Health Center with temporary staff moderately equipped; (2): Health Center poorly equipped and temporary staff; (1): Health Center poorly equipped and unsuitable staff; (0): With no health center
CV4 Services	(4): Complete installation with water, electricity, telephone line, and Internt; (2.70): Installation of water from aquaductand electricity (1.33): Installation of water and water from well; (0): With no electricity and no source of water nearby
CV5 Acceptance of the production system Aceptabilidad de la producción	(4): They are very happy with what they do, wouldn't do anything else, even if it meant more incomce; (3): They are happy, but they did better before; (2): They are completely satisfied. They stay because it is the only thing they know how to do; (1): Not satisfied with this style of life. They wish to live in the city and engage in a different activity; (0): They are disillusioned with their live, would not continue doing this.
CV6 Human diseases	(4): No disease associated to the use of agrochemicals; (2): Some disease associated to the use of agrochemicals; (0): More than one disease associated to the use of agrochemicals
Social Reproduction of the Family	
RS1Tenure of the land	(4): Owner with over 20 years with the same area; (2): Tenant with over 10 years; (0): Tenant with less than 5 years
RS2 Residence	(4): Lives in the farm; (2): Only on weekends; (0): Does not live in the farm
RS3 Generational replacement	(4): 3 or more descendents of family members work on the farm; (2): 2 descendents of family members work on the farm; (0): No family member workson the farm
RS4 Community participation	(4): Active participation in all the social organizations; (2): Active participation in at least one of the social organizations; (0): Does not participate in any organization
RS5 Ecological knowledge and conscience	(4): They concibe ecology from a broad vision, beyond their farm and know its basics; (3): They have knowledge about ecology from their everyday practice. Their knowledge is reduced to the farm; (2): They only have a reduced vision of ecology. They have the sensation that some practices might be damaging the environment; (1): They don't have knowledge about ecology nor do they perceive the consquences of some of their practices; (0): No type of knowledge about ecology. They engage in aggressive practices against the environment because of this lack of knowledge
RS6 Manpower	(4): Family laborers or reciprocity; (2): Partial laborers; (0): Paid laborers
Energy Efficiency and Conservation of the Natural Resources	
EFC1 Energy efficiency	(4): >1; (2): =1; (0): >1;
EFC2 and Energy productivity	(4): >1; (2): =1; (0): >1
EFC3 Yield	(4): more than 20 mt/ha; (3): 16 - 20 mt/ha; (2): 11 - 15 mt/ha; (1): 6 - 10 mt/ha; (0): 1 - 5 mt/ha
EFC4 Earthworms	(4): 21 or more; (2): 6 to 20; (0): 0 to 5
EFC5 Managing of plantations and diseases	(4): They engage in annual pruning of rejuvenation and/or sanitation. They substitute plantations every 10 years and sick varieties for more resistant ones; (2): They engage in pruning. They substitute plantations every 10 years and sick varieties for more resistant ones; (0): They don't prune and keep old plantations.
EFC6 Incidence of plagues and diseases	(4): No diseas or plague in the last year; (3): Some diseases or plague in the last year that affected 10% of the production; (2): Some diseases or plague in the last year that affected more than 10% and less than 50% of the production; (1): Some diseases or some plague in the last year that affected between 50 and 70% of the production; (0): Some diseases or some plague in the last year that affected more than 70% of the production

Table 1 (cont.). Description and weighing of indicators per analysis category, in a scale of 0-4.
Tabla 1 (cont.). Descripción y ponderación de indicadores por categorías de análisis, en la escala 0-4.

Indicator	Standarization of values
Quality of life	
EFC7 Biological activity in the soil	(4): There is a lot of life in the soil (100 or more little animals); (2): There is somelife in the soil (between 10 and 99 little animals); (0): There is little life in the soil (less than 10 little animals)
EFC8 Predominant slope	(4): from 0 to 5; (3): from 5 to 15; (2): from 15 to 30; (1): from 30 to 45; (0): > 45
EFC9 Vegetation cover	(4): all year around; (2.70): from 4 to 8 months; (1.33): at least 3 months; (0): never
EFC10 Furrow orientation - barriers	(4): Terraces, live or dead barriers and drainage furrows; (2): Individual terraces of plateaus; (0): No type of practice for soil convertions.
EFC11 Time diversity	(4): Rotation of non-fruit species every 10 years. They leave the lot in fallow for one year or incorporate leguminous plants or green manure; (2.70): They rotate with other fruit plants. They don't let the soil rest nor do they incorporate; (1.33): Every so often they rotate; (0): They do not rotate
EFC12 Spatial diversity of crops and surrounding natural vegetation	(4): ≥ 3 associated crop species, lots surrounded on at least 50% of their boundaries with natural vegetation; (2.70): 2 associated crop species and surrounded on at least one side with natural vegetation; (1.33): Monocrop and surrounded on at least one side with natural vegetation; (0): Mono crop surrounded by other crops, wastelands or roads
EFC13 Var association/phenol phase	(4): ≥ 3 varieties/several phenological phases; (2): 2 varieties/several phenological phases; (0): 1 variety / 1 phenological phase
EFC14 Rationality in the use of chemical/biological supplies	(4): rational use of some chemical and biological products; (2): Use of large variety of agrochemical products and some biological ones; (0): Use of large variety and quantity of agrochemical products
Autonomy vis-à-vis the Markets	
AM1 Sales diversification,	(4): More than 6 products; (2.70): 4 to 5; (1.33): 2 to 3; (0): 1
AM2 Number of commercialization channels	(4): At least one safe channel for commercialization during adverse conditions; (2): 3 to 4, in normal conditions; (0): 1 or 2 in normal conditions
AM3 Dependence on external supplies	(4): from 0 to 20; (3): from 20 to 40; (2): from 40 to 60; (1): from 60 to 80; (0): from 80 to 100
AM4 Profit margin	(4): more than 46%; (2.70): 31% - 45%; (1.33): 16% - 30%; (0): 0 -15 %

For the analysis, the altitude of the farm changed from a continuous variable to an ordinal one: Altitude 1 from 1,388 to 1,582 m a. s. l. includes the sectors of Jarillo Abajo and Tierra Caliente, Altitude 2 from 1,661 to 1,791 m a. s. l. includes the sector of La Enea, and Altitude 3 from 1,822 to 1,942 m a. s. l. includes the sector of Enea Arriba. The second part of the questionnaire was prepared taking into consideration the proposal by Astier *et al.* (2011), about the attributes of the sustainability and the categories of analysis that allow for a better description of the farms (table 1).

Categories of analysis

Quality of life

It refers to the state of wellbeing in which the producers and their families can satisfy their basic needs and participate in community life and the cultural traditions; at the same time, they have awareness of the need to maintain an equilibrium of the ecosystem and of the interdependency of the human being and nature.

The degree of satisfaction was measured by calculating the indicators: Housing (CV1), Access to education (CV2), Access to health care and health coverage (CV3), Services (CV4), Acceptance of the production system (CV5), and Incidences of human diseases (CV6).

Social reproduction of the family

This category is developed considering the concept of the family social reproduction strategies in an approximation to what Bourdieu (1972) presents, according to which the productive activities are considered as strategies that tend to reproduce the fundamental characteristics of a system, in this case socio-ecological (B). Said strategies can maintain or improve the conditions of the social structure of said system. In this sense, the following indicators were considered: Tenure of the land (RS1), Residence (RS2), Generational replacement (RS3), Community participation (RS4), Ecological knowledge and conscience (RS5), Manpower (RS6).

Energy efficiency and conservation of natural resources

The understanding of the energetic factor, as an ecological element in agriculture, and the acceptance of the flow of energy, as an emergent quality of the agro-ecosystems, allows having better mechanisms to assess the agricultural practices. The requirements of external energy to the farms in the agricultural farming processes are closely related to the levels of modification of the natural processes of the eco-systems. From the standpoint of sustainability, the energetic analysis considered the amount of energy harvested, compared to the quantity of energy coming from non-renewal sources (15, 21). Details of energy efficiency calculations were described elsewhere (26)

The improvement and conservation of the base of the natural resources is a necessary task in agriculture. It should be achieved by the managing practices and by the actions that lead to the minimization negative impact on the protection and the improvement of the natural capital, and by the strategies for their managing (1, 3).

The context of this research considers that the degree in which an agro-system increases its ecological sustainability depends basically on its management by using the optimization of the following processes: Availability and balance in the flow of nutrients; Protection and conservation of the soil surface; Preservation and integration of biodiversity; and Use of varieties adapted to the existing environmental heterogeneity that responds to operation with few external supplies and plague and diseases control (25).

For the construction of this category of analysis, the energetic indicators were taken into consideration: Energy efficiency (EFC1) and Energy productivity (EFC2), and the ecological indicators: EFC3=Yield, EFC4=Earthworms, EFC5=Managing of plantations and diseases, EFC6=Incidence of plagues and diseases, EFC7=Biological activity in the soil, EFC8=Predominant slope, EFC9=Vegetation cover, EFC10=Orientation of the furrows and the existence of soil conservation barriers, EFC11=Time diversity, EFC12=Spatial diversity of crops and surrounding natural vegetation, EFC13=Crops Variety association/phenological phase per lot, EFC14=Rationality in the use of chemical/biological supplies (table 1, page 355-356).

Autonomy vis-à-vis the markets

The agricultural production system that can satisfy the economic needs of the farmer is considered economically sustainable, without undermining the natural capital. This is why it is necessary to consider the capacity of the agroecosystem to offer the required level of goods and services. In the context of this study, it is understood as the capacity the agro-eco-system has to generate the necessary products that satisfy the demands of the farming families. For this reason, the following indicators have been considered: AM1=Sales diversification, AM2=Number of commercialization channels, AM3=Dependence on external supplies, AM4=Profit margin (table 1, page 355-356), (Sarandón *et al.* 2014).

Statistical analysis

The data were systematized and a matrix was created with 25 rows (farms) and 44 columns (variables). We carried out descriptive statistics with the matrix using Excel, and the multivariete analysis Principal Component Analysis (PCA) and Cluster with the Infostat program (13, 16).

The PCA is a multivariate method whose objective is to convert a very complex statistical information problem (many quantitative variables measured in each observation unit) into another almost equivalent but more manageable (few new variables) without significant information loss (12).

The technique obtains linear combinations of all the original variables that are orthogonal among themselves. This way as subset of new variables is reached that are independent, but that are highly correlated with the original variables, called original components, that when organized in a decreasing order according to their variance explain the variable percentage of the data for each component (figura 6, page 363).

Consecutively, each observation of the sample reaches punctuation in each of the main components selected, which allows to order the observations based on the multivariable information. In this study, the main components were obtained diagonalizing the correlation matrix, given that the different variables have different units of measure and each variable contributes with the same importance.

The result of the PCA is visualized by a biplot with the two main components, the farms and the 44 variables, linked. Subsequently, the nine most important variables of the PCA were used that had a correlation above 0.3 with regards to the two main components, such as the input to carry out the cluster analysis. The result was four groups, made up from dividing the dendrogram at half the scale of the distance. The productive systems that make up the four groups of the PCA and the four of the cluster coincided, from there that the typification cast four types of productive systems.

Results and discussion

Socio-demographic information

Of the 60 interviewed families, more than 66% has members older than 30 years of age, with a proportion of 53-47% between women and men, respectively. The extended family represents 90%, made up of parents, children, and grandparents. The average number of families per farm is three and the average number of people per farm is seven. Of the young people in the age of higher education, more than 90% of the women continue university studies. It has beeb observed a positive relationship between rural women's level of education and age and their level of participation in the decision making process within the farm (Boza *et al.*, 2018).

On the other hand, the young men finish high school but do not continued to higher education because they prefer to dedicate themselves to activities related to the commercialization of agricultural products or tourist activities of the area.

Quality of life and social reproduction of the family

A summary of the indicators grouped in this category are presented in spider graph form (figure 2, page 359), the closer to four the average value pondered of each indicator is, better the performance and larger the hexagone created in the spider graphs.

Figure 2A (page 359), shows the indicators of Quality of life (CV1 to CV6) with very good performance. With the exception of farm 26, all the families interviewed were owners of the land and lived in the farms. Each family works and individually administers its farm with its own economic organization that enables a more equitable distribution of the income among the members of the family. Social Reproduction of the Family showed good performance of the indicators above two (figure 2B, page 359), with the exception of the indicators of Ecological knowledge and conscience (RS5=1.8), which is coherent with the result of other indicators such as Dependence on external supplies (AM3=0) or the Rationality in the use of chemical/biological (EFC14=0.48). This dynamic improves the quality of life of the inhabitants of El Jarillo, and favors the sustainability because it depends less on external factors (15).

The area has a favorable climate and a geographical condition that allows an infrastructure to develop tourism and offer activities such as paragliding, walks around the area, restaurants with typical German food, sale of agricultural products harvested in the community, and local breads and sweets prepared by the local people. They maintain a very detailed care of the aesthetics, keeping a common façade for the houses and public service buildings, linked to the German heritage of the culture. This constitutes one of the touristic attractions of the area (figure 3, page 360).

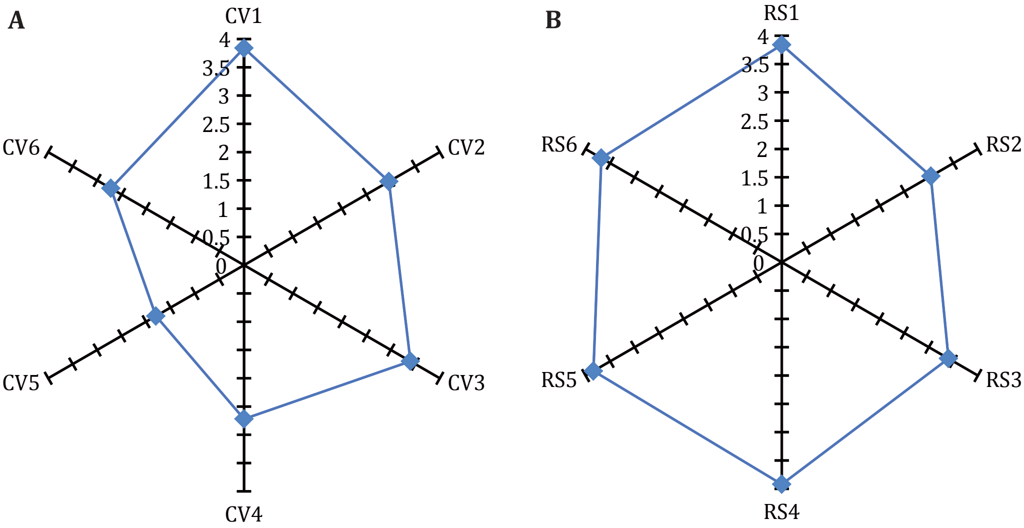


Figure 2. Summary of the category Quality of Life (A, CV1-CV6), and Social Reproduction of the Family (B, RS1-RS6) (table 1, page 355-356).

Figura 2. Resumen de la categoría Calidad de vida (A, CV1-CV6), y Reproducción social de la familia (B, RS1-RS6) (tabla 1, pág. 355-356).

As health service infrastructure, it has an outpatient primary health care that offers: vaccinations, dentistry, general medicine, gynecology, pediatrics, healthy children checkups, pre-natal care, four nurses, and two permanent ambulances. According to the statistics, this center treats motorcycle accidents, convulsions, respiratory insufficiencies, paragliding accidents, childbirths. As for educational institutions, it has four high schools, three elementary schools, in Quiripital, la Ciénega, and Quebrada Honda; there is also a preschool. It has a catholic church constructed in the architectural style of the area that the locals show with pride. In addition, it has several restaurants, a commercial center, three agrochemical stores, a bank, a petrol station, three hardware stores, a pharmacy, and an auto spare part shop.

In reference to the satisfaction of basic needs, the results show that the producing families live in very good quality houses with all the services and good road access, thanks to the actions of the Community Councils. Likewise, according to the results, there is a high acceptance of the production system, 84% of the farmers were very happy with what they do and would not engage in another activity, even if it would offer more income.

The majority actively participates in all the social organization of the community (Water Technical Committee, Community Councils, Asojarillazo *(El Jarillo Association)*). The generational replacement is one of the indicators that favors the largest sustainability because 72% of the farming families work the land with at least three family members of different generations; 12% has at least two descendants, the remaining 12% has no family member to replace them.

These categories, Quality of life and Social reproduction of the family, show a positive balance in favor of sustainability because the families have internalized agricultural production as a dignified way of life and have developed strategies that tend to continue with the system in the long run, in reference to sense of belonging, self-management, equitable distribution of resources, and community participation, the importance of the creation of spaces that guarantee that type of organization (as the community councils) has also been noted. Cuéllar and Sevilla (2009) call this, actions geared to control and self-management of the circulation processes seeking an endogenous socioeconomic transformation.

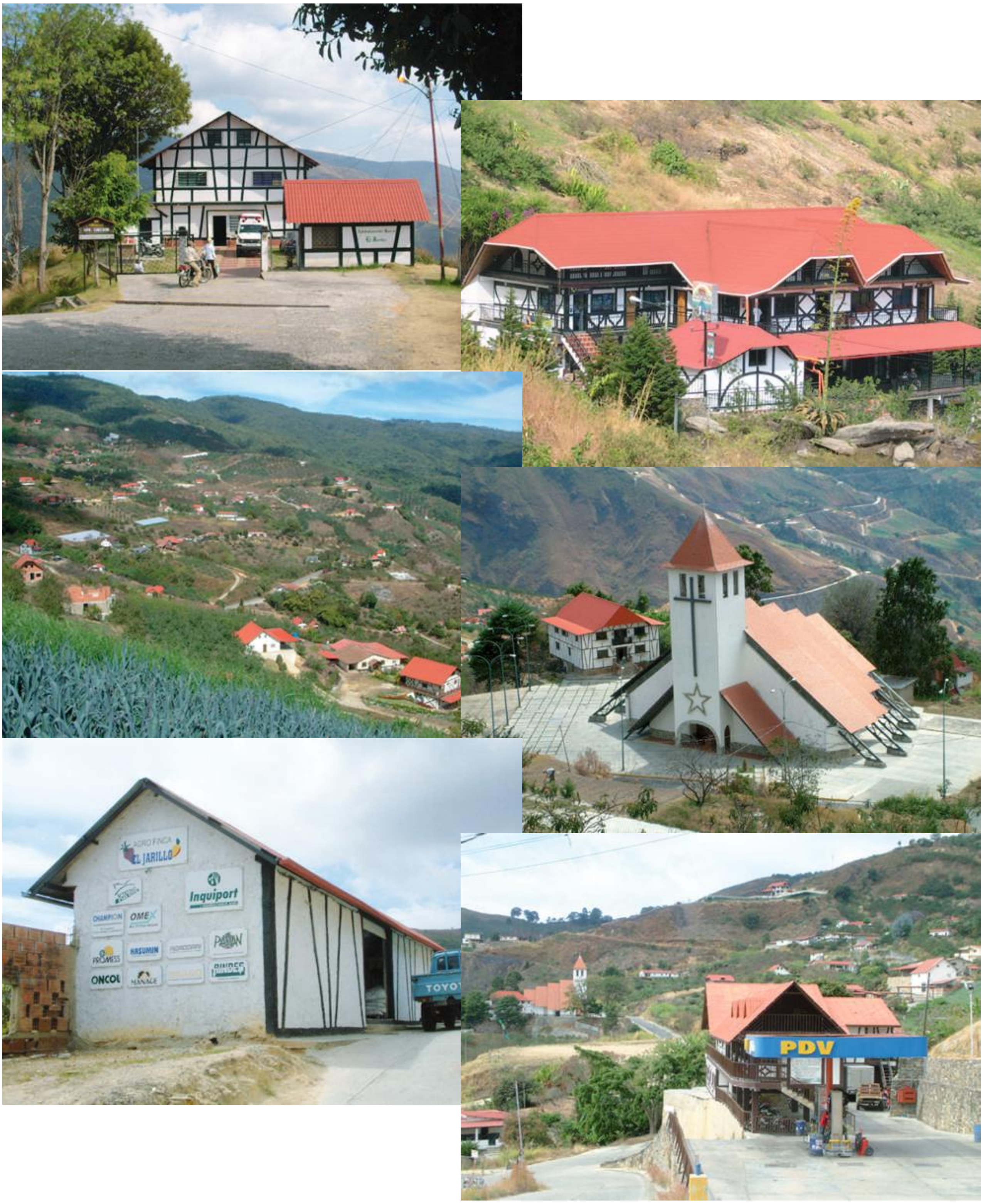


Figure 3. Photographic memory of El Jarillo, where the characteristic architectural style is shown. From left to right and from top to bottom: outpatient care, commercial center, panoramic of La Enera sector, catholic church, agrochemical store and gas pump.

Figura 3. Memoria fotográfica de El Jarillo donde se muestra el estilo arquitectónico que lo caracteriza. De izquierda a derecha y de arriba hacia abajo: ambulatorio, centro comercial, panorámica del sector La Enea, iglesia católica, tienda de agroquímicos y estación de combustible.

Energy Efficiency and Natura Resources Conservation

The indicators for Energy Efficiency, and Energy Productivity, (of the category energy efficiency) resulted with a value of zero (26) (table 1, page 355-356; for the ponderation of these indicators).

The dependency on products derived from oil makes these systems more vulnerable phasing changes concerning price and availability of oil. During the oil crisis of the years 1973, 1991, and 2008, the price of crude increased and this had a repercussion on the cost of agricultural production (15).

During the political, economic, and social crisis that Venezuela is undergoing, shortage is another of the problems the producing families face. The systems become more vulnerable with respect to external disturbances.

The key for a sustainable management of energy in agriculture is to use the renewable energy that is available in the system and that can be controlled locally, given that it does not damage the natural capital (21). According to Silva-Laya *et al.* (2017) the shortage crisis that the country is going through has contributed to improve the indicators of energy efficiency because they have reduced the use of agrochemical.

The results of the Life Conservation in the soil category can be seen in figure 4.

The observation of the soil of the farms by counting and identifying earthworms and macrofauna in 1 m^2 (25) provided an average between six and twenty earthworms and showed that also, in the majority of the cases, some other life can be perceived in the soil. Forty percent of the sample has predominant slopes above 45%, 36% with slopes between 30% and 45%, and only 16% has slopes between 15% and 30% (figure 4).

In reference to the vegetation cover, it was observed that 88% of the sample is covered at least three months per year. As for the Orientation of the furrows and the existence of barriers for soil conservation, it was observed that 96% of the farms do not have any type of conservation practice of the soils and that only one farm has done individual terraces.

The majority of the farms do not engage in crop rotation through time in the same lot. Only one farm rotates with other fruit plants. Spatial diversity means the association of crops to attain maximum efficiency in the use of the nutrients of the soil, the water, and the solar radiation; however, 80% of the farms have a monoculture (peaches or prunes), surrounded by other crops (prunes and trawberries), by unused plots, or by roads. Only 20% of the sample had at least two crop species associated and is surounded, at least, on one side, by natural vegetation (figure 5, page 362).

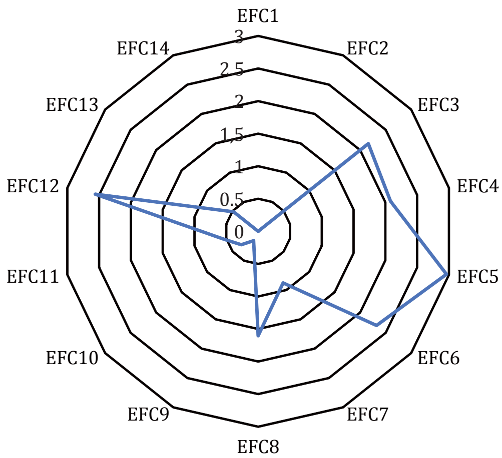


Figure 4. Energy efficiency and Conservation of natural resources and the use of technology (table 1, page 355-356).

Figura 4. Eficiencia energética y Conservación de los recursos naturales y el uso de la tecnología (tabla 1, pág. 355-356).

Figure 5. A)- Panoramic views of cultivated fields in El Jarillo. B)-defolitated peach plant during between harvest period. C)- Laborer applying agrochemical without adequate clothing.

Figura 5. A)- Vistas panorámicas de campos cultivados de El Jarillo. B)- Planta de durazno defoliada durante el periodo intercosecha. C)- Jornalero aplicando agroquímico sin indumentaria adecuada.

In this category, Energy Efficiency and Conservation of Natural Resources, the results are less favorable for sustainability.

The use of chicken manure has contributed with the good results of the indicators that measure the quality of the soil; however, this use of external fertilizers is a threat for both energy efficiency and independence of the producing families of the external market.

In accordance with Altieri and Nicholls (2009), if they would engage in more soil conservation practices, such as crop rotation and association, lots in fallow and vegetation cover, as well as, the adoption of an adequate nutrients cycling, they would get better results in the conservation of life in the soil and in the management of the natural resources.

Autonomy vis-à-vis the Markets

The average yield of the productive system was near 30%, nine resulted in a yield above 35%, five above 50%, eight with a yield above 20% and another eight with a yield between 13% and 20% (26) (table 2, page 363).

The indicators for Sales diversification and Number of commercialization channels came up with average values above the threshold value (2), 100% of the productive systems have a dependency on external supplies above 80%. Regarding Sales diversification, 85% has three or four products. Peach is the main crop and it is combined with prunes, strawberries, apples, pears, or tree tomatoes.

The indicator Number of channels for commercialization reported that 72% of the farms have, at least, one commercialization channel ensured in adverse conditions, and 28% has three or four channels under normal conditions. The Performance, measured in mt/ha, indicated very favorable values to sustainability; 36% of the farms produce more than 20 mt/ha, 44% produces between 16 mt/ha and 20 mt/ha; 12% between 11 mt/ha and 15 mt/ha, and only 8% of the sample is below the threshold of sustainability, with a value of one (between 6 mt/ha and 10 mt/ha).

Table 2. Summary of selected productive indicators and profitability of peach' farms in El Jarillo, Venezuela between 2009-2015.

Tabla 2. Resumen de indicadores productivos seleccionados y rentabilidad de fincas durazneras en El Jarillo, Venezuela entre 2009-2015.

Types of farm*	N° Farms	No. ha	No. Plants	Plants /ha	Cultivated ha
A (68%)	17	2.6 (0.5-7.5)	198.8 (70-600)	124.5 (100-166)	2 (0.5-6)
B (16%)	4	6.5 (1-15)	480 (120-1000)	130 (100-200)	4.8 (1-10)
C (12%)	3	1	100 (50-150)	116.7 (100-150)	0.8 (0.5-1)
D (4%)	1	1	100	100	1
Average		2.8	219.7	117.8	2.1

Types of farm*	Kg / harvest / Plant	TM / Harvest	% Return
A (68%)	129.7 (65-300)	25 (8.4-60)	30.7 (12.8-58.4)
B (16%)	113.8 (80-150)	53.5 (15-100)	31.3 (17.4-51.9)
C (12%)	108.3 (80-125)	11.5 (4-18)	31 (19.2-39.4)
D (4%)	120	12	18.5
Average	117.9	25.5	27.9%

Table 3 (page 366) and figure 6. / Tabla 3 (pág. 366) y figura 6.

The results of this category, Autonomy vis-à-vis the markets, show the productive systems as economically profitable (figure 6) since they allow the producing families to satisfy their economic needs, but it is not sustainable in time because they undermine the natural capital. Furthermore, the dependence on external supplies constitutes a threat to the system (6).

Typification of the Farms

El 97 % of the farms belongs to owners and 3% is leased. Most farms have between three and five hectares (52%), fallowed 33% with two or less cultivated hectares and only 14% has more than eight hectares. All of the farms grow peaches as the main crop, 60% of them grows prunes and 33% grows strawberries. These orders constitute the category in importance. Seven percent of the farms grows apples, pears, figs, and tree tomatoes for sale.

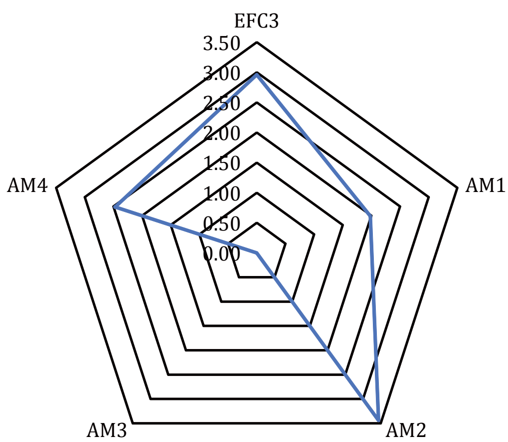


Figure 6. Category Autonomy vis-à-vis the Markets (table 1, page 355-356).

Figura 6. Autonomía de la categoría frente a los Mercados (tabla 1, pág. 355-356).

In the categories that are grown for self-consumption (33% of the farms), there are avocados, scotch bonnet peppers, garlics, onions, spring onions, strawberries, guavas, little oranges, tangerines, apples, oranges, potatoes, bell peppers, prickly pears.

The average peach cultivated area is 3.5 ha, with an average production per plant per harvest of 140 kg and a productivity of 17 MT/y/Ha. Productivity is supported by the use of chemical supplies.

The PCA applied to the complete data matrix with the 44 original variables-indicators (25x44), allowed the identification of those that explained in a larger extent the total variability of data (data not shown). This way, nine components explained 80% of the total variance, fairly high to explain the characterization of the system (12). For determining which variables were the most important, in terms of its correlation with the nine selected components, only those with r≥0.3 were considered. The first component (PC1) is the one that had the highest variance and, therefore, the greatest capacity to explain the data. In this case, it reaches 16.5% of the total (figure7, page 365). With this first component, the positive values were observed in proportions more or less the same as the variables that reflect the category of analysis Conservation of the Natural Resources: Biological Activity in the soil (NRC5); Rationale in the use of External Supplies, chemical or biological (NRC12); Vegetable Coverage (NRC7) and Earthworms (NRC2). Regarding how these variables are linked to the concept of biological activity in the soil and to the rational use of external supplies in the farm, it can be pointed out that the high values of this component are linked to a farm where the biological activity of the soil (earthworm, insects, and other species display of the edaphic microfauna) is abundant.

The second component (PC2) explains 12.5% of the total variability (figure7, page 365) and was linked (r≥0.3) at most to the number of families per farm (Fam), number of members per family (Intg), and the number of working age people between 16 and 60 years (p16-60).

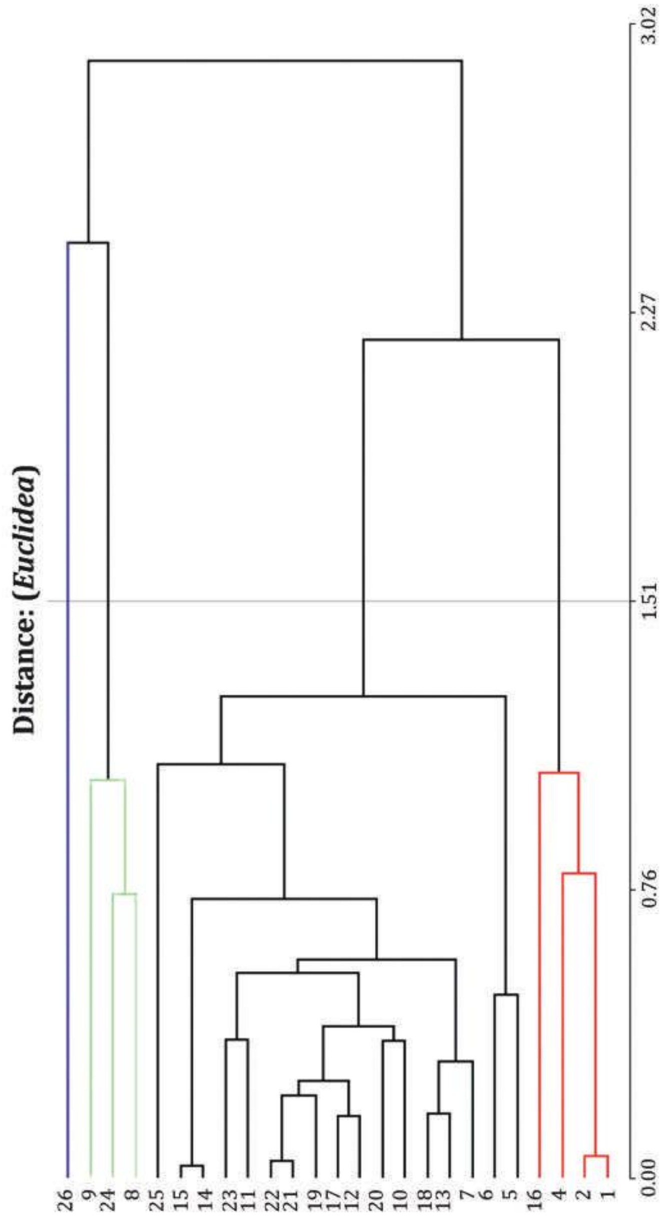
Relating this component with the first could indicate that the number of people in the farm could better do the work in the farm, with a direct impact in the biological activity of the soil. While more members of the family participate in the productive activities the better care is taken in the maintenance and/or sanitation pruning, which would require applying less chemicals; thus, resulting in an increase of the biological activity in the soil.

PC3 interprets 11% of the total variability, all with positive values (data not shown). It refers to peach kg/plant, number of crops in the farm, number of other fruit species in the farm (apples, pears, tree tomatoes, avocadoes, figs, little oranges, tangerines, oranges, prickling pears, and guava), and the number of crops destined to self-consumption (vegetables). This can infer that this component is related to the number of plant species grown in the farm, especially peaches.

The rest of the components are related to the majority of the subvariables of the different categories analyzed. Eighteen variables explained 20% of the total variance (data not shown), grouping the less important variables in the analysis. Moving away from the PC1, the variance proportion explained by the most relevant variables of the others components, reduces considerably.

A representation of the farms by means of a PCA biplot using all the 44 indicators showed four groups (data not shown). The cluster analysis using the nine variables with greater correlation with the first two components of PCA, also groped the farms in four groups by their similarities. These groups were obtained when the dendrogram was cut in half (figure 7, page 365). Both the PCA and the cluster analysis grouped the farms into four groups, which coincided completely. This result allowed, in consequence, to typify four types of farms in El Jarillo (table 3, page 366).

The biological activity of the soil allowed to differenciate 84% of the productive systems of El Jarillo in types A-B with lower levels than types C-D. These indicators were correlated with the PC1. Second in importance (PC2). They were grouped by the number of peach plants, total hectares, number of crops, and number of families that make up the system. The majority of the productive systems centers on the stone fruits with high yield for the locality (Type A).



The vertical line indicates the four types of production systems. / La línea vertical indica los cuatro tipos de sistemas productivos.

Figure 7. Grouping of El Jarillo farms according to the nine variables with the highest correlation with the main components (PC1 and PC2).
Figura 7. Agrupamiento de las fincas de El Jarillo en función de las nueve variables de mayor correlación con los componentes principales (PC1 y PC2).

Tabla 3. Características principales de los tipos de fincas de El Jarrillo.

Table 3. Main characteristics of the types of farms of El Jarrillo.

Types *	Characteristics**	%
A	Farms focused in peach and prune productions for sale. They do not grow strawberries and have 1-2 crops for self-consumption. They are on average small (3.32 ha) and have a yield of >140 kg plant^{-1}per crop. They are inhabited by 1-3 families with 1-4 working members.	68
B	Farms focused in peach and strawberry production for sale, although they are more diversified because they commercialize in a smaller scale other product (prunes, tree tomatoes, and apples) and they grow for self-consumption (=3.5). Its average size doubles the previous category (7.5 ha) and the have a yield of >140 kg plant^{-1}per crop. They are inhabited by 3-5 families with 4-12 working members. Characterized by low biological activity in the soil.	16
C	Farms focused in peach production for sale. They are scarcely diversified to sell other products or to provide for self-consumption. They have a medium average size (=3.0) and the have a yield of >140 kg plant^{-1}per crop. They housed between 3-5 families with 4-7 working members. They outstand by their high biological activity in the soil.	12
D	Only grow peaches, none of the other nineteen fruit species or horticulture that exist in the totality of the other farms. The peach has a yiel dof<140 kg plant^{-1} per crop. This type is inhabited by 1-3 families with 1-4 working members. Present high biological activity in the soil because of the use of chicken manure. Only one farm differentiated in this category.	4

* Figure 7 (page 365). / * Figura 7 (pág. 365).

** The grouping of the sytems was not related to the altitude of the farms, considering the Pearson Chi2 statistic, not significant according to the contingency analysis.

** El agrupamiento de los sistemas no mostró relación con la altitud de las fincas, considerando el estadístico Chi2 de Pearson, no significativo según el análisis de contingencia.

Others dedicate their combined efforts to growing peaches and strawberries, although with less yield (Type B). From the analysis of the CP3, and in third place of importance, it was evident that the systems were differenciated by the purpose of the production whether it be self-consumption/sales and by the return. The yield allowed to differenciate Type C and and Type D systems, given that the second only grows peaches. Type D was conformed by one productive system.

In a previous typification of these systems in El Jarillo, Soto *et al.* (2004), identified two types of production systems basically differenciated by the varity of peach grown. One of the systems is based on the yellow Criollo variety, at an altitude of 1,200-1,600 m a. s. l., with family laborers, in lots with 400 plants.

The other system grows Jarillazo, at 1,800-1,900 m a. s. l., with fences as a way to use the laborers. It handles lots of about 600 plants. With the methodology used in this work, altitude had little weight at the moment of separation of the majority of the systems (Types A and B). On the other hand, it did contribute to separate Type C from D, and, at the same time, these two from A and B (see that the altitude variable (Alt) is presented parallel to the axes of the X in figure 7, page 365).

Both, in the analysis of Soto *et al.* (2004) and in the case of this research, three fundamental processes for production were identified, and that are defined in their manner in the handling of natural resources: i) control of biotic stress (plagues and diseases), ii) handling of water and nutrients (use of fertilizers and organic matter), and iii) control of flowering (allows at least one and a half harvest per year).

The two former process are common on cultivation of plants, but peach also requires a forced growing cycles with three harvest per 2 years in order to get higher value in the market (13). The application of chemical fertilizers is commonly used in the four types of systems identified in this study. The nitrogenated fertilizer is applied at the rate of 200 kg/ha. The systems Type A use less quantity of chemical fertilizers, but a lot more organic compost like poultry manure (> 1MT/ha). This type of handling has negatively influenced the indicators of the category Energy efficiency and conservation of natural resources (26), and, thus, it represents a threat to the sustainability of the system.

Conclusions

The socioecological systems of El Jarillo turned out to be fairly homogeneous in relation to the four analysis categories, both in its interactions with the environment and the handling systems of its crops; in this last case, the systems based on techniques the green revolution for forced production of at least one and a half crops per year, to fertilize and control plague and diseases. Nonetheless, in accordance with the variables used, four types of productive systems were identified in the 27 studies of the 90 counted in the area. All the systems concentrate their efforts in the production of peaches for sale.

In terms of the analysis categories, the study reports that the strategies of social reproduction of the families, in the family agriculture of El Jarillo, tend to maintain their own and autonomous characteristics, especially in the production of peaches. Through more than a century, they have maintained the conditions of the social structure.

The agriculture in El Jarillo is strongly integrated to the productive skills and ways of life of the inhabitants of El Jarillo. However, the natural resources suffer grave deterioration and the local productive technology is a threat for the conservation of the natural resources; therefore, for the sustainability of the system in the long run.

The production of peach is economically viable for most of the farms subject of this study because of the low economic risk and the high rentability, despite the fact that there is a strong dependency on external supplies. Nonetheless, the multidimensional analysis clearly shows that sustainability of the farms does not only depend on the growth in financial gains but also in the consideration of increasing other aspects such as energy efficiency.

The changes of the natural processes of the agro-eco-systems for artificial processes based on external chemical supplies outside the farms influence considerably in the high-energy cost; this makes that the systems be energetically deficitary and that the improvement and the conservation of the base of the natural resources be a necessary task.

The quality of life standards of the farming families of El Jarillo are the product of the high rentability and the moderate economic risk, at the expense of the natural resources that are handled less favorably for sustainability.

The degradation of the natural capital is masked by economical capital, by means of chemical supplies that come from outside the farms in order to achieve the levels of production and income necessary to satisfy the needs of the farming families.

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