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# Evaluation of family agriculture production systems through thresholds for the construction of sustainable proposals, Penipe Canton

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## ABSTRACT

Peasant family farming is one of the main suppliers and is responsible for guaranteeing food sovereignty. A particular interest is given to the functioning of the productive system, which seeks to determine, through the analysis of critical points and thresholds, to define sustainable alternatives, translating the general principles of sustainability into definitions and operational practices. The objective of this study was to valuate family farming production systems through productive thresholds with the purpose of proposing sustainable alternatives for the improvement of the agricultural system in the Penipe canton. The methodology of this study included the establishment and generation of attributes, diagnostic criteria, and critical points to make a comparison with the productive thresholds, applied to nine farms representative of the three productive typologies. In this study, the three production systems of the Penipe canton were evaluated. We proposed alternatives for each of them, such as the implementation of new agroecological management strategies, the generation of organic fertilizers, the production of bio inputs, the strengthening of interdisciplinary approaches through the adoption of technological innovations and research, the increased participation of different owners throughout the production process, and the promotion of associativity, which provides the design of new alternative production systems. In conclusion, specialized family farming poses alternatives for improvement in terms of the provision of quality seeds, technical management, greater management, and government support. Diversified family agriculture will be ontained by

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government management and execution, training, adoption of innovations, dependence on external resources, crop risk, yields, access to credit. In the productive aspect, deficiencies were found in root development, pending involvement, irrigation water, organic matter, soil cover, and subsistence family agriculture, followed by land tenure and occupation, social connection, government management and execution, training, adoption of innovations, dependence on external resources, crop risk, yields, access to credit, as well as productive aspect deficiencies in root development, affectation of the slope, irrigation water, drainage, organic matter, soil cover, management, and plant development.

**Keywords:** Production systems, Family farming, Sustainability, Food sovereignty, Thresholds.
**Article type:** Research Article.

## INTRODUCTION

The vision of managing sustainable agricultural systems depends mainly on increasing the efficiency of the use and exploitation of resources, ensuring sustainable production, conservation, and harmonization of biodiversity and scarce natural resources (Tilman *et al.* 2002); while increasing the resilience of production systems in the face of growing risks is related to climate, biotic stress and economic variations (Pretty *et al.* 2011). The perspective projected to improve agricultural production is related to increasing production, yields per unit of energy expenditure, water, soil, nutrients, also reducing the use of external inputs (Gonzálvez 2017). During the last 50 years, agriculture has intensified through the use of genetically modified varieties considered high yielding. The technological fertilization and irrigation and the use of synthetic pesticides have contributed substantially to the increase in food production and sovereignty in the world, supplying a growing global population (Bayliss-Smith 1991). The correlation between the intensification of agricultural production, the use and management of natural resources and the economic condition of producers is complex, since the productive system currently managed directly impacts natural and economic resources. Having an implication to the environment, the personal health and income of farmers (Pengue 2009).

**Sustainable agriculture approach**. Sustainable agriculture should be developed in a way that farmers increase their economic income without compromising the ability to satisfy future needs, nor wearing down biodiversity and existing natural resources (Del Angel & Nava 2019). Agricultural systems capable of facing future challenges are those that show high levels of biodiversity, productivity and efficiency (Pengue 2009). The agricultural transformation process should encompass greater food production, the conservation of biodiversity, the promotion of the appropriate use of redistributive ecological services, and socioeconomic aspects in a harmonious environment, in which producers interact with researchers for the adoption of new technologies (Salazar Sanabria & Pérez Martínez 2020).

**Guidelines for sustainable agriculture**. Within the guidelines to evaluate the processes of a sustainable agricultural system, it is necessary to define a comprehensive framework that contemplates social, economic and environmental metrics, which determine whether a productive agricultural system is being managed in a sustainable manner. Ávila Sánchez (2015) indicated that the establishment of social, economic, agronomic, ecological, geopolitical, and environmental guidelines serve as a basis for producers to be able to promote more efficient agriculture. The idea behind establishing a set of agronomic, ecological, social, economic and environmental guidelines is that if producers follow them, they should be able to promote more efficient agriculture, conserving biodiversity and directly benefiting their communities (Altieri *et al.* 2012). Gavito *et al.* (2017) proposed guidelines focused on the environmental, social, labor and agronomic management of farms, based on the three pillars of sustainability, which are social equity, environmental protection and economic viability, hoping to result in less soil wear (erosion), reduced waste (pollution), better balance of biodiversity, fewer risks to human health and improved living conditions for producers. Work spaces should be formed in a territory made up of: family farmers, authorities, NGOs and consumers who express the main restrictions and limitations within the productive system, which will be pointed out at critical points (Pretty *et al.* 2011). These in turn will be analyzed, studied and evaluated to propose alternative solutions, which will improve the food security panorama and the income generated can remain in the community (Zulaica *et al.* 2022).

**Fundamental attributes and objectives of sustainable agriculture**. Bertran (2017) defined that the imperative need to cover the planet's hunger promotes the design and staggering of sustainable agricultural systems, analyzing the approaches to biodiverse, productive, resilient, and efficient agriculture in terms of the use of available resources on farms. Haro *et al.* (2022) stated that conservation agriculture, sustainable intensification, genetic improvement, organic agriculture, and agroecological systems are the proposed approaches that have a theoretical and stable basis to determine a sustainable food production strategy (Fig. 1).

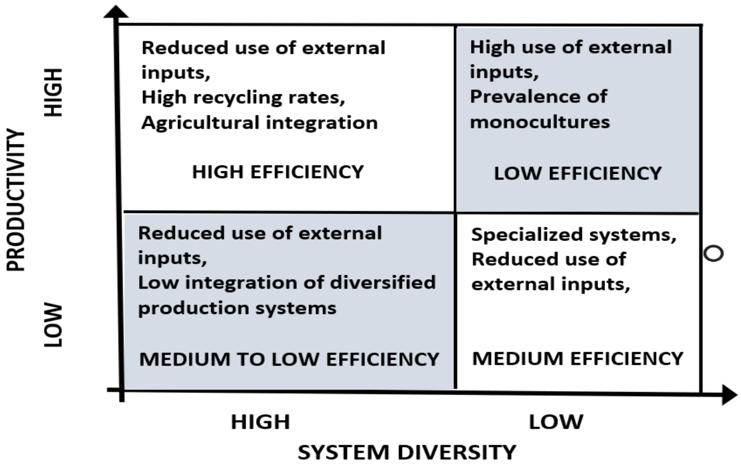


**Fig. 1.** Characteristics of productive systems: productivity, diversity, integration, and efficiency; Source: Bertrán (2017).

To consolidate this strategy, we started with a critical point analysis of the productive systems, anchored to their attributes, within which there are criteria on agroecology and sustainable agriculture that will be the basis for considering whether the productive systems are sustainable (Altieri *et al.* 2012). The basic attribute to generate sustainability is the maintenance of biodiversity and the ecological services of the agroecosystem, within the interactions between the producer and the productive system (Altieri *et al.* 2012). The internal regulation of the functioning of systems depends on the level of biodiversity of living beings and their surrounding environment. This consists of a variety of ecological services that go beyond food production, harmonization of microclimate processes and hydrological cycles, nutrient recycling and the reduction of the use of synthetic pesticides (Bertran 2017). Within the productive system, an important task is to identify the indicators that present management or performance problems, identifying undesirable environmental changes and the actions to be executed, so that the system improves as a whole (Camacho *et al.* 2021).

**Definition of performance thresholds in sustainable agriculture**. For the evaluation of production system processes, performance thresholds are first determined to later define inflection points, hence the system can function normally, considering the limits of efficient use of natural resources, having the capacity to also provide environmental services as inputs into the system (Loaiza *et al.* 2014). The thresholds of the productive system constitute the minimum quantity, hence the system can function adequately, considering as transitional processes the values that remain close to the productive threshold (Veisi *et al.* 2016). Loaiza Cerón *et al.* (2014), pointed out that in the analysis of thresholds whose values are above the performance levels, a trend towards sustainability begins, valuing the economic income of the productive system, income, expenses, stability (frequency of disasters) within the productive system, considering them as producer satisfaction indicators, while nutrient balance, organic matter content, soil depth, water retention capacity, soil cover and biodiversity are used as indicators of conservation and resource efficiency. An indicator is at a sustainable level, as long as it exceeds a designated level of each threshold. The thresholds are established provisionally, based on the conditions of the local environment (Del Angel & Nava 2019). The individual values obtained, derived from the evaluation of the production systems, are compared with the thresholds, where upon reaching the threshold level a rating of one is assigned. Only farms that achieve an average rating of more than one for farmer satisfaction and resource conservation are considered sustainable (Loaiza *et al.* 2014).

**Strategies to achieve sustainable agriculture (thresholds and attributes).** A strategy to make agricultural development proposals presented by Veisi *et al.* (2016) is to identify the thresholds of each attribute, to establish agricultural production strategies that should be met to develop sustainable agriculture. A threshold-based evaluative approach allows: (a) to have an alert or warning of possible imminent damage or loss in the production system before a threshold is exceeded; (b) facilitates the monitoring of changes within the production system once technologies have been adopted to improve the production system; and (c) suggest alternatives, changes or new visions in which the applied technologies can be useful within the established thresholds (Loaiza *et al.* 2014). The thresholds are defined and adapted depending on the place or region where the production system is located, considering all socioeconomic, cultural, geopolitical, ecological, and productive conditions. Systems that fall below the thresholds are considered unsustainable, included systems that greatly exceed the established threshold, therefore, they will require modifications to their productive structure (Veisi *et al.* 2016). Loaiza *et al.* (2014), stateed that the thresholds can also be determined by analyzing whether the agricultural production system can meet the requirements of food, energy, and technological sovereignty. Food sovereignty is understood as access to safe, nutritious, and culturally appropriate food in sufficient quantity and quality to preserve a healthy and humanly dignified life, while energy sovereignty is the right to have access to sufficient energy within ecological limits from appropriate sustainable sources for appropriate use within the productive system. Altieri *et al.* (2012) stated that technological sovereignty refers to the management and innovation capacity adapted to the productive system to achieve the two other forms of sovereignty, promoting environmental services derived from existing agrobiodiversity and using locally available resources. A productive system is considered sustainable or has achieved its sovereignty, if it meets the threshold levels established in a participatory manner for each type of sovereignty.

## MATERIALS AND METHODS

### Study area

The study was carried out in the Penipe canton, located northeast of Chimborazo Province, Central Ecuador whose coordinates are x: 793964,73; y: 9841403,66, z: 2620 masl. For the evaluation and determination of alternatives, nine representative farms were selected, three of each typology, based on the study carried out by Haro (2022) in which the production systems were characterized, resulting into three typologies. These are: Specialized family agriculture (SFA), which is characterized by being the main source of income from agricultural activities corresponding to 75%. Diversified family agriculture (DFA) characterized by its majority source of income from various off-farm activities with 75% and 25% corresponding to agricultural income, and family subsistence agriculture (FSA) whose income and products allow them to survive. According to the Altieri *et al.* (2012) and Veisi *et al.* (2016) seven sustainability attributes were established, including: Productivity, resilience, adaptability, reliability, stability, equity, self-management, and 37 critical points. These were evaluated through pre-established surveys, on-site analysis, and collection of samples for laboratory analysis of the selection of 3 representative farms of each production system coded as follows: specialized family agriculture, i.e., SFA01, SFA02, SFA03, diversified family agriculture: DFA04, DFA05, DFA 06 and family subsistence agriculture: FSA07, FSA08, FSA09, to later make an average and compare it with the production threshold value. Altieri *et al.* (2012) and Loaiza *et al.* (2014), compared agricultural systems with the productive threshold level [the minimum value of an indicator (1.25) above which a trend towards sustainability begins], Therefore, an indicator is said to be at a sustainable level, if it exceeds a designated level. Thresholds are provisionally established based on average local conditions, in order to define the inflection points, with which the system can function normally. Guaranteeing food, social, environmental and productive sovereignty, considering the limits of efficient use of natural resources, taking into account the capacity to also provide environmental services as inputs into the system (Pretty *et al.* 2011; Camacho *et al.* 2021).

## RESULTS

Within the analysis of the attributes and critical points of family farming production systems, i.e., Specialized Family Farming (SFA), Diversified Family Farming (DFA) and Family Subsistence Farming (FSA), their thresholds are determined by indicating the reference of non-sustainable system (NS) and sustainable system (S). As shown in Table 1 to subsequently generate alternatives towards a sustainable system, in accordance with food, energy and productive sovereignty, set out in Table 2, corresponding to the evaluation of attributes, productive systems, sustainability and productive thresholds. Sustainability assessment using systemic approaches receives primary attention due to its potential as a decision-making tool. Therefore, Loaiza *et al.* (2014), stated that this evaluation is carried out through productive thresholds, stating that an indicator is at a sustainable level if it exceeds a designated level. These thresholds are based on average local conditions in order to define the tipping points at which the system can operate normally. Guaranteeing food and productive sovereignty, considering the limits of efficient use of natural resources, as well as the ability to also provide environmental services as inputs into the system (Cedillo *et al.* 2011; Veisi *et al.* 2016).

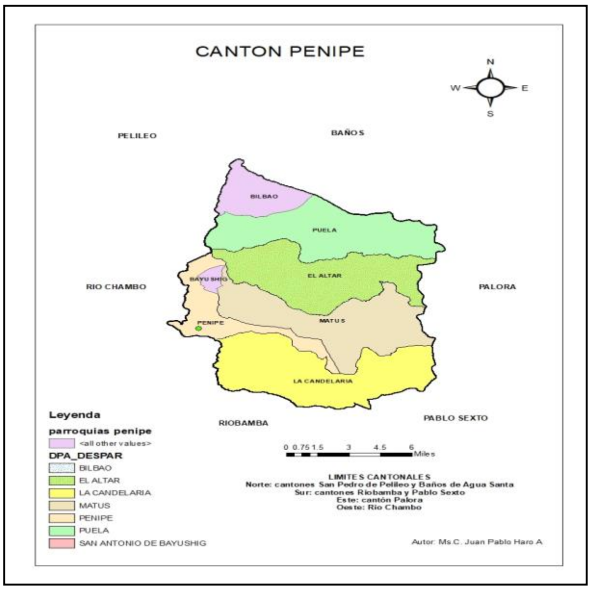


**Fig. 2.** Political map of the Penipe canton, with its respective parishes; Source: This study.

**Table 1.** Evaluation of attributes, Productive Systems, sustainability, and Thresholds.

| **Atribute** | **Critical Point** | **Average Data of the Typologies** | | | **Threshold** | **Comparison result with the Threshold** | | |
|---|---|---|---|---|---|---|---|---|
| | | AFE | AFD | AFS | THRESHOLD | AFE | AFD | AFS |
| **Productivity** | Productivity ( planning ) | 1.33 | 0.67 | 0.00 | 1.25 | NS | NS | NS |
| **Productivity** | Productivity (B/C) | 1.67 | 0.33 | 0.00 | 1.25 | S | NS | NS |
| **Productivity** | Productivity ( Yield ) | 1.00 | 0.67 | 0.00 | 1.25 | NS | NS | NS |
| **Stability, resilience, reliability** | Pending | 1.67 | 2.00 | 2.00 | 1.25 | S | S | S |
| **Stability, resilience, reliability** | Root development | 2.00 | 2.00 | 1.00 | 1.25 | S | S | NS |
| **Stability, resilience, reliability** | Plant development | 2.00 | 1.00 | 1.00 | 1.25 | S | NS | NS |
| **Stability, resilience, reliability** | Erosion | 1.67 | 1.33 | 1.00 | 1.25 | S | NS | NS |
| **Stability, resilience, reliability** | Soil Infiltration | 1.00 | 1.00 | 1.00 | 1.25 | NS | NS | NS |
| **Stability, resilience, reliability** | Water Irrigation | 1.67 | 1.33 | 1.00 | 1.25 | S | S | NS |
| **Stability, resilience, reliability** | Drainage | 2.00 | 2.00 | 1.33 | 1.25 | S | S | S |
| **Stability, resilience, reliability** | Organic material | 1.00 | 1.00 | 1.00 | 1.25 | NS | NS | NS |
| **Stability, resilience, reliability** | Conservation Practices | 2.00 | 1.33 | 0.00 | 1.25 | S | S | NS |
| **Stability, resilience, reliability** | Plant Biodiversity | 2.00 | 2.00 | 2.00 | 1.25 | S | S | S |
| **Stability, resilience, reliability** | Animal biodiversity | 2.00 | 2.00 | 2.00 | 1.25 | S | S | S |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Stability, resilience, reliability** | Trend towards monoculture. | 1.33 | 1.33 | 1.00 | 1.25 | S | S | NS |
| **Stability, resilience, reliability** | Productive accidents | 1.00 | 1.00 | 1.00 | 1.25 | NS | NS | NS |
| **Stability, resilience, reliability** | Pests and diseases incidence | 1.00 | 1.00 | 0.00 | 1.25 | NS | NS | NS |
| **Stability, resilience, reliability** | Climatic production zone | 2.00 | 2.00 | 2.00 | 1.25 | S | S | S |
| **Adaptability** | Training Generation of knowledge | 1.67 | 1.33 | 0.33 | 1.25 | S | S | NS |
| **Adaptability** | Innovation | 2.00 | 1.33 | 0.00 | 1.25 | S | S | NS |
| **Adaptability** | Adoption of innovations | 2.00 | 1.00 | 1.00 | 1.25 | S | NS | NS |
| **Adaptability** | Knowledge and application of agroecological practices | 1.33 | 1.33 | 0.00 | 1.25 | S | S | NS |
| **Adaptability** | Land ownership | 2.00 | 2.00 | 1.67 | 1.25 | S | S | S |
| **Equity** | Inequity in decision making | 1.33 | 1.33 | 1.00 | 1.25 | S | S | NS |
| **Equity** | Schooling index | 1.33 | 1.00 | 0.33 | 1.25 | S | NS | NS |
| **Equity** | Ignorance of government policies | 1.00 | 0.67 | 0.00 | 1.25 | NS | NS | NS |
| **Equity** | Government management and execution | 1.00 | 1.00 | 0.00 | 1.25 | NS | NS | NS |
| **Equity** | State agricultural planning institutions | 1.00 | 0.67 | 0.67 | 1.25 | NS | NS | NS |
| **Self-management** | Participation and social connection | 1.67 | 1.67 | 0.67 | 1.25 | S | S | NS |
| **Self-management** | Dependence on external resources. | 1.33 | 1.00 | 1.00 | 1.25 | S | NS | NS |
| **Self-management** | Low diversification of economic income. | 1.67 | 2.00 | 1.00 | 1.25 | S | S | NS |
| **Self-management** | Credit access ability | 2.00 | 1.33 | 0.33 | 1.25 | S | S | NS |
| **Self-management** | diversificación de productos | 2.00 | 1.33 | 0.33 | 1.25 | S | S | NS |
| **Self-management** | supply of seedlings and seeds. | 1.00 | 1.33 | 1.00 | 1.25 | NS | S | NS |
| **Self-management** | commercial articulation. | 1.00 | 1.00 | 0.33 | 1.25 | NS | NS | NS |
| **Self-management** | Food sovereignty | 2.00 | 1.33 | 0.33 | 1.25 | S | S | NS |
| **Self-management** | access to basic services . | 2.00 | 2.00 | 1.00 | 1.25 | S | S | NS |
| **S: Sustainable** | | | | | | | | |
| **NS: Not sustainable** | | | | | | | | |

## DISCUSSION

**Specialized Family Agriculture.** Of the total (37) critical points analyzed, there were 11 below the productive threshold, which affected the sustainability of systems such as: provision of quality seeds and plants, productivity planning, crop yield, impact of pests and diseases, low organic matter content in soils, water infiltration into soils, climate change (productive accidents). These factors limit productive performance. Piovesan (2012) considered that productive factors depend on the good use of natural resources and the interactions that are generated in them. Ignorance of public policies, management, poor government participation, and weak commercial coordination undermine the development of the productive system. Seddon & O'Donovan (2013) considered that the lack of government coordination and the devaluation of work in the countryside reduces the regions opportunities for progress

**Diversified Family Agriculture.** Once analyzing the 37 critical points, 16 of them were below the productive threshold, including: supply of quality seeds and plants, productivity planning, benefit-cost ratio, crop yield, impact of pests and diseases, low organic matter content in soils, water infiltration in soils, erosion, climate change (productive accidents), dependence on external resources, considering that the productive aspects are of vital importance as well as their successful management to achieve the objectives within the farms (Altieri *et al.* 2012; Abadía Cabrera 2017). Ignorance of public policies, management, poor government participation, weak commercial coordination, the adoption of technology, and the low level of schooling limit the development of the productive system. According to the study by Salazar Sanabria & Pérez Martínez (2020), these problems affect the normal development of the system and poor decision-making regarding the use of natural resources (García & Anaya 2015).

**Subsistence Family Agriculture.** By evaluating the 37 critical points, 31 were below the productive threshold, which is why the system is considered unsustainable in most of its attributes. Therefore, in this type of agriculture, we mainly find small properties or areas of land where a limited number of products are grown that are mainly intended for food and that do not have high yields for commercialization. According to the study carried out by (Del Angel & Nava 2019), unsustainable activities mean that there are no production surpluses due to the use of traditional tools far removed from modern agricultural techniques and methodologies, dependence on their own, generally unqualified labor, which is why productive systems decrease. To improve the management of the systems, we seek to develop sustainable agriculture, which seeks to satisfy human needs in terms of healthy eating through the basic principles of improving the quality of the environment. Efficiently using natural resources and preserving them, adaptation to natural biological cycles, as well as linking and supporting rural economic development to improve the producers' quality of life (Tilman *et al.* 2002). Table 2 depicts the alternatives and proposals in general, analyzing within the social, geopolitical, cultural, economic and environmental dimensions (technical, productive), for each typology of the Family Agriculture production system of the Penipe canton. All these premises have a sustainable agriculture approach with the aim of moving from traditional agriculture to a sustainable intensification of agriculture, innovation of agroecological processes, application of agricultural Big Data, smart and digital agriculture, and bio-economy (Altieri *et al.* 2012; Abadía Cabrera 2017; Haro 2022).

**Table 2.** Proposals and alternatives within productive systems, by dimensions.

| Dimensions | Problem | Proposals and Alternatives within Productive Systems | Typologies |
|---|---|---|---|
| **Social Geopolítico Cultural** | Land Tenure and Occupation | • Optimization of soil resources, formation of sustainable agricultural and forestry operating systems, crop diversification | AFS |
| | Government management and execution | • Establish agricultural public policies for the benefit of the farmer, as well as greater management for the participation of governmental and non-governmental entities.<br>• Management and implementation of research projects and their subsequent dissemination.<br>• Direct link between academia, Ministries, NGOs for technology transfer and research processes<br>• Compilation and analysis of information on all production processes, using BIGDATA for production planning.<br>• Promote focused technical advice, promote field practices and on-site professional practices. | AFS<br>AFD<br>AFE |
| | Participation and Social Bonding | • Promote associative social linkage, with the purpose of holding planning, execution, and training meetings in productive assemblies.<br>• Training, participation, and linkage in agro-productive chains<br>• Management of human resources, through the transfer of scientific knowledge and skills, associated with ancestral knowledge and cultural identity. | AFS |
| **Economic** | Credit Access | • Facilitate the processes and requirements for access to productive credits, increasing the lines of action. | AFD<br>AFS |
| | Income | • Implementation of accounting records by subsystems and components.<br>• Cost-benefit analysis: economic, environmental, and social.<br>• Promote ventures to generate a greater number of marketing channels | AFD<br>AFS |

| | | | |
|---|---|---|---|
| **Technical Environmental Productive** | Training and Adoption of Innovations | • Carrying out practical courses as well as training and agricultural extension workshops with a focus on technological innovation<br>• Demonstration plots on agroecological techniques for the use, conservation, and restoration of natural resources.<br>• Implementation of precision agriculture (satellite systems, agricultural technology) | AFD<br>AFS |
| | Dependence on external resources<br>Crop Risk | • Production of bio-inputs such as fertilizers and IPM control, strengthening the production of local fertilizers<br>• Use of resistant varieties.<br>• Manage records of adverse situations within the Penipe canton. | AFD<br>AFS<br>AFS<br>AFD<br>AFE |
| | Slope, Erosion Drainage | • On land with steep slopes, implement windbreak barriers (lupine, alder), formation of protein banks, conservation practices.<br>• Land susceptible to wind and water erosion, increase in permanent vegetation cover, Reduction of unnecessary use of agricultural mechanization practices against the slope and development of moisture retention ditches.<br>• Diversified agricultural activity (crop rotation). | AFD<br>AFS |
| | Water Irrigation | • For optimal use of soil and crops, reduce evapotranspiration and encourage infiltration. Moisture retention techniques. Provision of technical systems due to the scarcity of sufficient flow for plot irrigation. | AFD<br>AFS |
| | Organic material | • Composting area for organic fertilizer production,<br>• Production of Bio-inputs | AFS<br>AFD<br>AFE |
| | Animal Biodiversity | • Implementation and/or remodeling of pens, shade-houses, with the objective of a multipurpose contribution to the system<br>• Genetic, health and production records. | |
| | Root Development, Soil Cover and Plant Biodiversity (crop diversification) | • Promote the association of crops and their rotation, to maintain the energy of production systems.<br>• Driving components for the integration of agricultural, livestock and forestry subsystems.<br>• Multipurpose tree nursery and fruit orchard. | AFD<br>AFS |
| | Plant Management and Development - Yield | • Selected, certified and resistant seeds.<br>• Develop agroecological processes and principles such as: nitrogen fixation, nutrient recycling, allelopathy, integrated pest and disease management, carbon sequestration.<br>• Fertilization and bio-stimulants plan<br>• Harvest, post-harvest, and marketing plan | AFD<br>AFD |

## CONCLUSION

Penipe farmers belonging to the canton's family agriculture, whose typologies are specialized, diversified and subsistence family agriculture, tend to adopt experiences or technologies that they consider appropriate with respect to their objectives, preferences, and analysis of resource limitations as well as its economic, natural, social, and environmental characteristics. Prospective technologies can be adopted, from a vision superior to those traditionally available. Reaching the values agreed upon by the three types of agriculture requires exceeding productive thresholds. Therefore, the combination of all alternatives will provide food, productive and energy sovereignty to the systems, promoting the adequate use of natural resources without compromising them for future generations. Among the proposed alternatives, the aim was to intervene through priority actions within the productive system, new management strategies or productive modification (implementation of bio-inputs), strengthening interdisciplinary approaches, identification of development of new capabilities that will be covered through the adoption of technological innovations, and research, the increase in the participation of different owners throughout the production process, the articulation of various spatial scales of analysis, which provides the design of new alternative production systems.

Family farming production systems present certain deficiencies within critical points and inflection thresholds. We analyzed with reference to farmer satisfaction and resource conservation, thus represented each type of family agriculture separately: **Specialized family agriculture**: government management and execution, risk in the cultivation and concentration of organic material. **Diversified family agriculture**: government management and execution, training, adoption of innovations, dependence on external resources, crop risk, yields, income, access to credit. Within the resource conservation aspect we found deficiencies in root development, slope, irrigation water, drainage, organic matter, soil cover, management and plant development. **Subsistence family agriculture:** land tenure and occupation, social ties, government management and execution, training, adoption of innovations, dependence on external resources, crop risk, yields, income, and access to credit. Within the resource conservation aspect we found deficiencies in root development, slope, irrigation water, drainage, organic matter, soil cover, management and plant development.

## CONFLICTS OF INTEREST

There is no conflict of interest to be declared by the authors of the research.

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