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Family Farming as a Key Element of the Multifunctional and Territorialized Agrifood Systems as Witnessed in the South Pacific Region of Costa Rica

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Abstract: In Central America, Family Farming (FF) is characterized by the fostering of endogenous development, self-sustaining economies, food safety and upholding the values of the agricultural landscape. However, government agricultural policies have promoted an external model of development based on industrial monocultures, which generates socioeconomic and environmental instability, deficient models of agroproduction commercialisation and the impoverishment of agricultural landscapes. This article details the case of 60 farms from 22 communities in the municipality of Buenos Aires, in the South Pacific region of Costa Rica, where biological/physical, socioeconomic, marketing and governance issues of a Multifunctional and Territorialized Agrifood System have been characterized based on the family unit of production. In addition, a differentiation was made between peasant and indigenous farmers as their cultural backgrounds may then lead to their adopting different attitudes and distinct actions. By analysing the productive diversification of the models, the behaviour of the local marketing channels and their associative potential, the socio-ecological characteristics of the region were identified, including the strengths and weaknesses that should influence the model of agroproductive development and regional governance.

Keywords: South Pacific; agrosystems; family farming; governance



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1. Introduction

Territorialized agrifood systems are conceived and built as alternatives to the dominant agro-industrial model, and in accordance with the criteria of sustainable development through the proximity between farmers, processors and consumers. The consolidation of such systems depends on the local productive potential, the capacity for cooperation between the actors, and efficient institutional arrangements and governance [1] to favour micro, small and medium-sized agrifood enterprises and networks, as well as the establishment of alternative marketing channels based on the Family Farming model (FF) [2–4].

When considering the environmental and ecological impact on the rural landscape, FF contrasts with monoculture agroindustry as it better favours genetic, species and land use diversity in the agricultural landscape [5], while the latter tends towards a more homogeneous landscape [6,7], limiting the diversity of the resources available to the different species that inhabit it [8]. Given that agriculture is considered the human activity that represents the greatest threat to the conservation of biodiversity [9], the heterogeneity and diversity that FF brings to the rural landscape, especially in a tropical environment [10], can help maintain the balance between productive systems and nature conservation [7].

In the context of Central America, FF is characterized by fostering endogenous development, self-sustaining economies, food safety and upholding the value of agricultural

landscapes [11,12], acting as a mechanism that helps resist the negative impacts of globalization in the rural environment [13]. Currently, FF is considered the main type of agriculture in Latin America, with a participation of more than 60 million people and about 16.5 million farms, of which 35% are in Mexico and Central American countries [11,12,14], contributing to rural employment in the range of 36% and 76%, and with 2.4 million families involved in FF [11,12,15,16]. The FF model favours the availability of food, raw materials and resources, and providing added value to the local production by rural agro-industries [11,12,16]. After Mexico and Guatemala, Costa Rica is the country in Central America with the third largest number of people who practise FF (79,000) [17], representing 55.4% of all farms, and making it an essential model to guarantee food safety, the eradication of poverty, and the conservation of natural resources and biodiversity [11,16,18].

The practice of FF in Costa Rica is based on a mixture of cultural heritage in relation to crop and animal diversity, coupled with the location and the agroecological characteristics of the land [14,16]. The Bribri and Cabécar are indigenous people of Talamanca who employ an agrop productive practice called polyculture, which consists of planting, managing and harvesting in a manner that seeks to imitate the forest, and produce goods that can be used or that can be exchanged and are symbolic [19]. In the South Pacific region, it is common for farmers to use FF practises based on traditional polyculture techniques (known by indigenous people as Sköwak) in conjunction with those of conventional agriculture (known by indigenous people as Sikua: [19–21]. This type of FF model that combines traditional and conventional production techniques is important for the conservation of biological and landscape diversity [22,23]), as well as ecosystem services maintenance. Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services, regulating services, cultural services, and supporting services such as soil formation, photosynthesis, and nutrient cycling [24]. However, as a food system, FF faces difficulties caused by the extreme reduction in the surrounding biodiversity, which generates some imbalances in the agroecosystem and leads to the need to employ other resources and to use additional management practices, such as those related to pest control and the use of fertilizers [21,22,25].

The agrifood systems of peasant and indigenous farmers in the South Pacific of Costa Rica are the result of a cultural and biological coevolution over time, as well as the continued learning and transmission of knowledge regarding the use natural resources (e.g., the soil and water) and the conservation of agrobiodiversity [19], all of which is founded on diverse forms of collective territorial organization [26]. However, the prevailing state policies in Costa Rica and in Central America since the 1950s have provoked a transformation in the productive structures, moving towards a strengthening of the monoculture agro-industry like pineapple [27,28] to the detriment of multifunctional agrifood systems.

One of the challenges faced by FF in Costa Rica is that there is little existing information about the characteristics of this agrop productive model [16]. Accordingly, this study aimed to analyse the characteristics of FF—both that employed by peasants or of traditional origin and that of indigenous people or polyculture—as well as its role in territorial dynamics and its contribution towards enhancing the rural landscape. In addition, this analysis focuses on the threats faced by the FF-based production model due to the historical behaviour of the pineapple (*Ananas comosus*) agroindustrial model in the region. To this end, data was collected from 22 communities on the Pacific side of the Talamanca Mountain Range in Costa Rica, from the municipality of Buenos Aires in the South Pacific region. The traditional diversified agricultural production systems on the South Pacific seem to be able to conserve natural resources. In this regard, this research tries to answer the following question: How are the peasant and indigenous family farming models of the South Pacific region and what role do they play as multifunctional and territorialized agri-food systems? It is likely that the FF-based Agrifood Systems in the South Pacific region of Costa Rica can be a key element to curb the advance of an environmentally and socially unsustainable agroindustry.

2. Materials and Methods

2.1. Study Area

The study area is located in the Pacific foothills of the Talamanca Mountain Range, between 684 and 1414 metres above sea level (MSL). It comprises a total of 22 communities from five districts of the Buenos Aires canton: Volcán, Brunka, Buenos Aires, Potrero Grande and Biolley. These areas include the territories of two indigenous ethnic groups, the Cabécar of Ujarrás and the Bribri of Salitre and Cabagra, which are also part of the buffer zone of the “La Amistad” International Park (PILA: Figure 1).

The geographic area is situated in the General-Coto Brus Valley, considered to be a climatic subregion [29] that is located in the orographic shadow of the Talamanca Mountain Range to the northeast and that of the Fila Costeña to the south. This produces a drier climate relative to the coastal and mountain areas [30]. The average annual rainfall is 3050 mm and the average annual temperature is 23 °C, with maximum temperatures of 29 °C and minimums of 18 °C [29,31]. The climatic conditions of the valley allow the formation of semideciduous vegetation, wooded savannahs and patches of very humid forests, with a unique composition and a variety of floral elements restricted to those areas, where the presence of formations characteristic of savannahs stands out [30]. These ecosystems are influenced strongly by the marked climatic seasonality, and they are characterized by the predominance of grasses, with the presence of scattered trees and shrubs at different densities [32,33]. The climatic characteristics of high humidity and temperature are reflected in the regional soils, mainly in those of the Ultisol type. These are old, clay-like, acidic and highly weathered soils, which is why they present difficulties for agriculture [34]. This implies that farmers must implement special management techniques to improve soil productivity, especially those located on topographies with steep slopes. Because of this, the generally recommended use for these soils is permanent wooded vegetation.

According to the classifications of the vegetation in altitudinal zonations, that formulated by Holdridge (1947) [35] stands out as it uses the parameters of biotemperature, rainfall and potential evapotranspiration to define the so-called Life Zones. Nontransitional *very humid Pre-Montane Forest* and *very humid Pre-Montane Forest* that transitions to a basal state (warmer) are the Life Zones found in the study area [36]. However, it is in the Pre-Montane zone that is occupied by humans and where agroproductive activities have prevailed, greatly transforming the potential vegetation. In the case of the General-Coto Brus valley, cattle grazing in the old savannahs was established in colonial times, although today there are large extensions of pineapple monoculture. The municipality of Buenos Aires leads the pineapple production, covering an extension of 6870.82 ha, with Volcán (2699.64 ha), Brunka (1501.39 ha) and Buenos Aires (1297.32 ha) the three districts with the largest extension of pineapple crops [37].

Streamlining agricultural systems to improve their performance leads to high uniformity, which alters the biodiversity of the landscape [7,10,22]. In this sense, the negative environmental externalities of monocultures consist mainly of soil degradation, pollution and excessive use of water resources, as well as the loss of biodiversity due to the abuse of agrochemicals. This has been the case with the pineapple crops that have become common in the municipality of Buenos Aires since 1979 [21,25,38]. On the other hand, pineapple plantations have had a strong impact on the socioeconomic dynamics in the region as they have become one of the few alternative sources of employment and income for local inhabitants [39]. Although greater economic dynamism is manifested in the expansion of pineapple plantations in rural areas, behind the contributions to socioeconomic development attributed to monoculture agroindustry, negative externalities of a social and economic nature are also identified, such as the alteration of traditional peasant and indigenous production systems and the dependence on jobs in precarious working conditions, both in the fruit packing plants as well as on the farms [21,40]. Thus, this population is increasingly being employed for agro-industrial labour and to a much lesser extent in the management of the FF production plots [21,25].

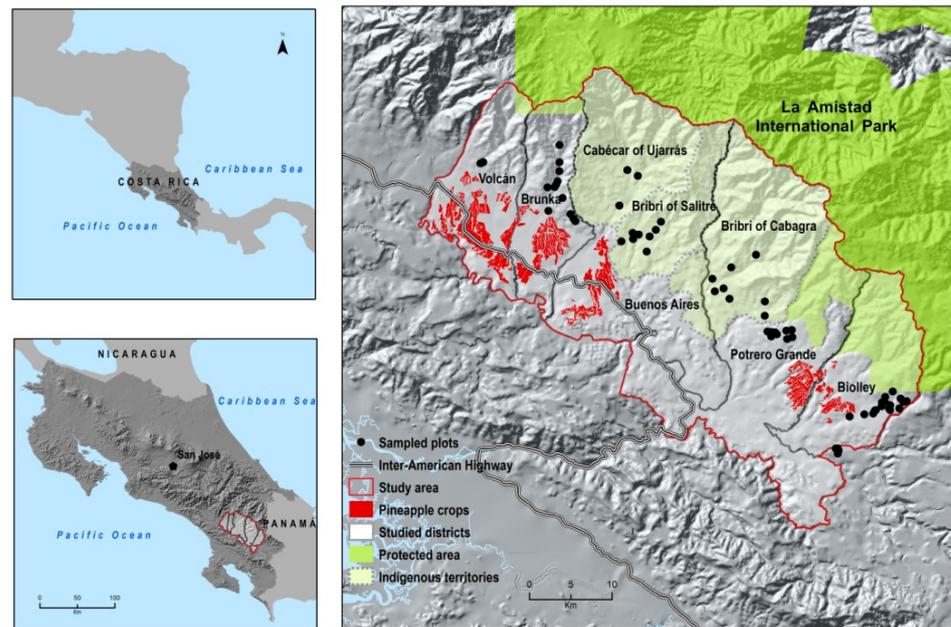


Figure 1. Location of the study area, the plots sampled and the distribution of the pineapple crops. Source: generated by the authors based on the cartographic distribution of pineapple crops [41] and the Costa Rica Atlas [42].

2.2. Methods

2.2.1. Biological and Biophysical Characterization of FF Production Plots

The study methods include the characterization of a total of 60 family agricultural production plots distributed in 22 communities, over a period between September 2017 and December 2021, involving 75 field visits. The inventoried plots are spread over the different districts studied: 2 in Volcán, 12 in Brunka, 9 in Buenos Aires, 16 in Potrero Grande and 21 in Biolley (Figure 1). The plots were chosen by random sampling along a strip of territory in the municipality of Buenos Aires, in the PILA buffer zone. The selection was made by choosing FF farms of (1) the peasant population (44 plots) that practices traditional agriculture based on a spontaneous empirical method to obtain knowledge and using traditional forms of knowledge transmission [43], combined with other agriproductive practices more advocated to the commercialisation like cattling, bee-keeping, coffee production, among others, and (2) the indigenous population (16 plots), made up of people from two ethnic groups that are direct descendants of the pre-Columbian population [44], and whose traditional agricultural system is a complex system of use and management of the agroecosystem, recreating the activities, structure and natural composition [20] and mainly focused on the family's self-sustaining. The indigenous FF farms are located within the three indigenous territories of the study area: Ujarrás, Salitre, and Cabagra (Figures 1 and 2). The plots of both populations were classified into four categories according to the management systems used [19,45]:

- Agrosilvicultural: combination of crops with woodland species;
- Silvopastoral: combination of woodland species with grasslands and livestock;
- Agrosilvopastoral: combination of the two management systems above;
- Traditional system or indigenous polyculture: based on a mix of different wild species and agricultural crops in the same space, integrated in the forest and emulating the diversity of natural ecosystems.

The methodological approach adopted was designed to obtain knowledge on the management of the productive plots in four dimensions: biological/physical, agrosystems, commercialisation and governance. For each dimension, various attributes were evaluated (Table 1).



Figure 2. Peasant and indigenous family farms. (A) View of a peasant farm; (B) Detail of a peasant family's vegetable garden; (C) Coffee growing in silviculture and polyculture in the indigenous territory of Cabagra; (D) Silvopastoral system with a predominance of shrub species in a peasant farm. Source: authors' own images.

The information obtained from the characterization of the FF plots made possible to determine the physical dimensions of the multifunctional territorialized agrifood systems from the configuration of the production unit, the dimensions, and the ecological contribution of the agrifood systems of the study area.

2.2.2. Characterization of the Socioeconomical Dynamics

The diagnosis of the FF model employed in the territory was carried out through field interviews with the farms' owners. To contextualize the dynamics of the agroproductive territory, various local actors were interviewed, selecting a nonprobabilistic sample composed of 70 informants (Table 2) based on the criterion of level of experience in the topic under study. A semi-structured face-to-face interview was carried out with each informant that was designed for two main profiles: a) indigenous and peasant agriproducers, by an interview instrument focused on understand the FF plot structure and the opportunities and limitations related to the production; and b) participants in the dynamics of local development (community leaders linked to associations, community platforms and indigenous local governments), and technicians, administrators and academics linked to government institutions in the environmental and agroproductive area, in order to understand the impact of the state on the regional economic development and territorial dynamics.

The interviews directly enquired about the technical criteria, perception and life experience of each informant regarding the following issues: the dynamics related to the preservation of traditional small-scale FF systems, their contributions to biological conservation and the problems that affect it, both in terms of the production and commercialisation channels.

2.2.3. The Processing and Analysis of the Information

The qualitative information obtained through the interviews was analysed and contrasted with the data previously obtained through a bibliographic review of technical and diagnostic documents of an economic, socioenvironmental and cultural nature for the region [5,6,18–21,23,25,38,46]. In this way, we hoped to define the factors that influence the management of the FF production units in the Pacific foothills of Talamanca on a more local scale. Furthermore, technical reports [37] and cartographic databases of pineapple cultivation on a 1:5000 scale were analysed [41], generated by the Monitoring Land Use

Change within Production Landscapes (MOCCUP, according to its Spanish acronym) system of the Airborne remote and in situ Sensing Research Program (PRIAS) Laboratory at the National Centre for High Technology (CeNAT). Mapping was carried out using ArcMap 10.8.1 software based on the cartography from the Digital Atlas of Costa Rica prepared at a scale of 1:50,000 by the Costa Rica Institute of Technology [42], and incorporating our own information layers generated during the field work, mainly regarding the geolocation of the productive units and communities in the study area.

The methodological process of the research was developed in 4 phases. Phase 1: selection of the FF plots. Phase 2: related to the characterization of the FF plots. Phase 3: on the preparation of the analysis cartographic bases. Phase 4: of data collection through interviews (Figure 3).

Table 1. Attributes of the productive plots.

Dimension	Attributes Level 1	Attributes Level 2
Biological/Physical	Production unit area (ha)—Extension	
	Layout of the production unit	- Form
		- Topography
		- Distribution of the areas managed
Ecosystem services	- Forest cover and composition	
	- Forest preservation	
	- Conservation of water resources	
Agrosystems	Farming systems	- Biological connectivity
		- Peasant farming
	Management systems	- Indigenous farming
		- Agrosilvicultural
- Silvopastoral		
Product diversification	- Agrosilvopastoral	
	- Polyculture	
Commercialisation	Family nucleus	- Type of crops
		- Proportion of each crop
	Access to financing	- Composition and participation in the management of the productive plots
		- Bank mortgage loans
Governance	Focus on high market value products	- Nonreturnable funds
		- Type of product
	Marketing channels and networks	- Type of network
- Type of product reaching the market		
Engagement with co-operative associations	Land tenure	- Affiliation to some organisation
		- Type
		- Problems

Source: generated by the authors.

Table 2. Type of actors interviewed.

Actors	Code	Type of Actor	Interviews
Associations and Platforms	Lc	Community leader	2
	Ac	Academic	1
Institutional	Gap	Protected areas manager	1
	Tag	Agricultural technician	1
	Tam	Environmental technician	2
	Tmu	Municipal technician	1
Peasant Farmers	Agni	Peasant agriproducers	44
Indigenous Farmers	Agpi	Indigenous agriproducers	16
	Lci	Indigenous community leader	2
Total			70

Source: generated by the authors.

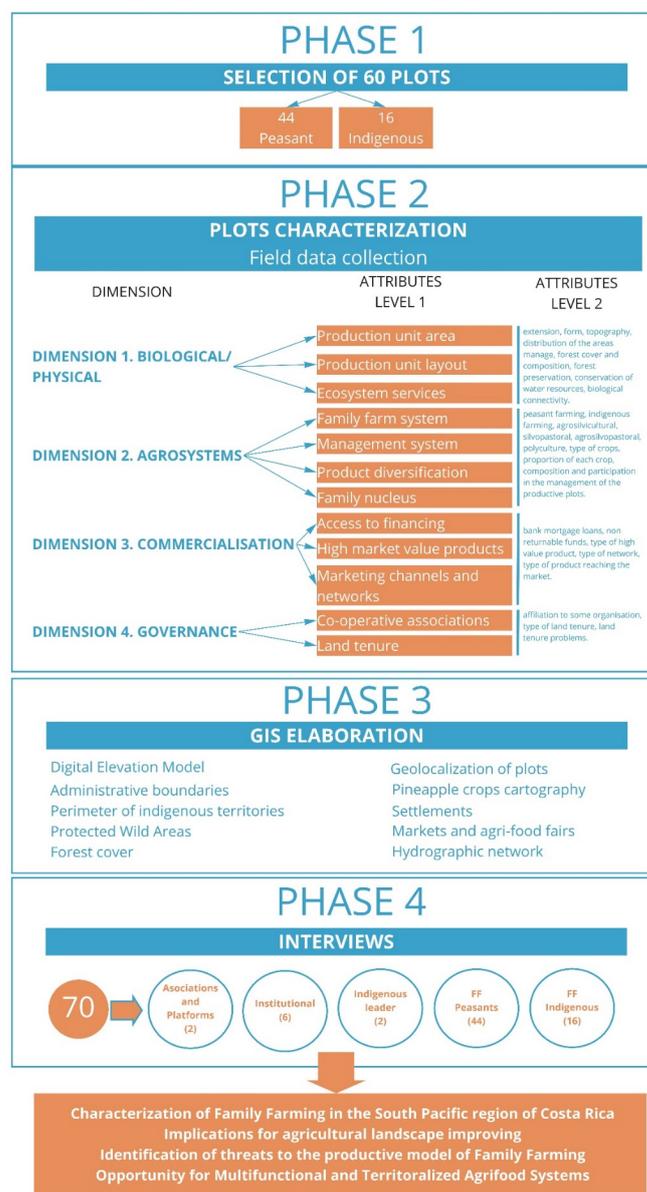


Figure 3. Scheme of research methodology. Source: generated by the authors.

3. Results

The systems based on FF in Latin America and the Caribbean are subject to the patterns of consumption of the developed countries [23,25], as it happens in other contexts such as developing countries of Southeast Asia [47,48]. With the arrival of the industrial production of pineapple in the South Pacific in the 1970's and the increase in the land dedicated to its farming, a series of structural, social and economic changes were produced in this area that further weakened the FF agroproductive systems. Indeed, farmers were faced with the dilemma of maintaining a self-supporting economic model, for which the technical and economic state support available was inferior to the stimulus offered to the agroindustry, and the need to employ cheap labour to maintain the low production costs of pineapple [49,50]. These factors have defined the current economic and territorial models in the region, where multifunctional agrifood systems still survive [21,51].

3.1. The Physical Dimensions of the Multifunctional Territorialized Agrifood Systems

By characterizing 60 FF farms, we determined that the FF plots in the study area cover an average area of 4.7 ha, with differences between the plots situated inside (2.1 ha, Agpi) or out of (4.6 ha, Agni) the indigenous territories (Table 2).

3.1.1. Configuration of the Production Unit

According to the data obtained, the layout of the productive unit, which is usually defined by the topography, the geographical relief of the terrain, and the rivers and streams that serve as natural boundaries, is irregular in 75% of the plots. In addition, they are characterized by a layout in which the house, the work and maintenance spaces are the nucleus of the farm's dynamics. The main access to the plot leads directly to the house, which in 87% of the cases was located on the flattest point of the land. In those cases where the plots were located along a watercourse, 13% of the houses were situated near the lower levels of the plot, especially the oldest ones because houses were traditionally built close to water sources. The results obtained regarding the characteristics of the farms show clear differences between the two types of plots (peasant/indigenous agriproducers: Figure 4). Peasant FF farms have three perimeters. A first perimeter around the house and the maintenance infrastructures, in which the orchard is located, the vegetables, legumes, tubers, cucurbits and plants for medicinal use are grown, and the sheds for milking cattle and for the pigs and poultry are situated. The farmers take particular care of these spaces due to the risk of these crops and domestic animals being attacked by wild animals. In a second perimeter, coffee crops and basic grains are usually located, most often managed through agrosilvicultural, silvopastoral and agrosilvopastoral systems in which the coffee is usually combined with musaceae (*Musa* spp.), cassava (*Manihot esculenta*), cocoa (*Theobroma cacao*), different fruit species and nitrogen-contributing species like *Inga edulis* or *Erythrina* spp., among other tree and shrub species that have for different uses (Table A1). A third perimeter is usually made up of conserved patches of forest that alternate with areas of pasture for the cattle. These non-indigenous peasant farms are usually managed as silvopastoral systems in which the use of live fences is prevalent, usually made from species such as blackwood trees (*Gliricidia sepium*), nance (*Byrsonima crassifolia*) and different species of fruit trees (Figure 4).

In the plots where indigenous polyculture was carried out, two areas were identified (Figure 4). A diversified orchard is in the first perimeter that protected the house and the maintenance infrastructures. Deferring with the peasant plot, here the pigs and poultry frequently live free and move between the first and second perimeter and far beyond, between neighbouring farms, but always spending the night in their shelters nearby the house and the maintenance infrastructure. This kind of management takes less effort of maintenance and care by the owner. The second perimeter encompassed the agriculture crops and forest areas, configured as a single unit including a permanent polyculture system composed by fruit species and a temporary monoculture system of basic grains, and used for collecting other forest resources through gathering and, to a lesser extent, hunting.

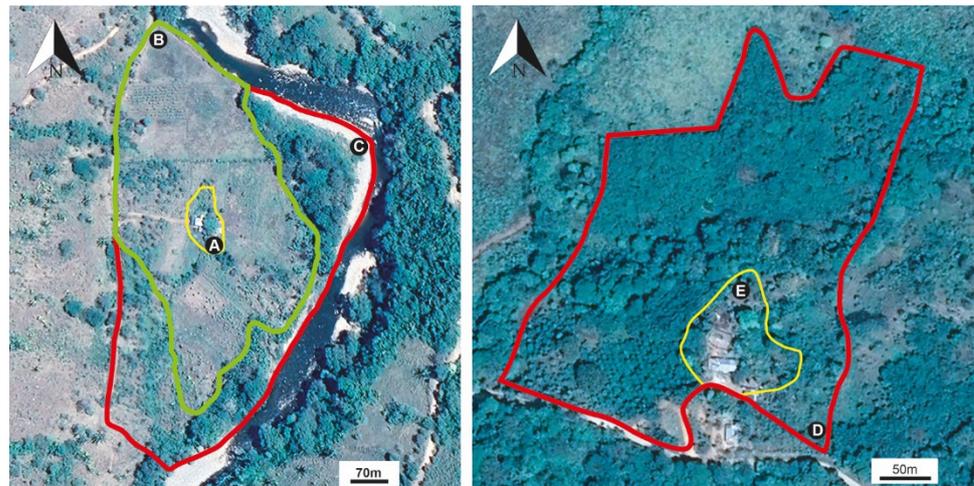


Figure 4. Examples of the layouts of FF plots in the municipality of Buenos Aires. On the left, peasant management; (A) First perimeter with the house and orchard; (B) Second perimeter with the coffee and basic grain crops under different management systems; (C) Third perimeter with conserved forest. On the right, the indigenous polyculture management; (D) First perimeter with the house and orchard; (E) Second perimeter with the crops integrated within the forest. Source: generated by the authors from Google Earth/Image © 2021 CNES/Airbus images.

3.1.2. Ecosystems of the Agrifood Systems under Study

With regards to forest conservation and the richness of the tree stratum, the data obtained show that 91.6% of all the plots analysed have areas dedicated to forest conservation (primary, secondary or regenerating forests). In the case of the indigenous farms, the forest not integrated into the polyculture management system corresponded to 39.7% of the total area, while this represented a much lower percentage (25.2%) in the case of peasant farms (Table 2: Lc, Agni, Agpi).

A total of 76 species were identified in the tree–shrub stratum of the plots, belonging to 35 families and 65 genera (Table A1). The species catalogued were located within the forest patches and in other areas of the indigenous peasant farms where they are found in combination with crops. Of the total species, 28 are used for food, 27 for timber and 5 for medicines. The tree vegetation was categorised according to the criteria of the International Union for Conservation of Nature [52,53], identifying two species categorised as Threatened (*Beilschmiedia anay*, *Guaiacum officinale*) and one categorised as Vulnerable (*Cedrela odorata*). These species are conserved in both peasant and indigenous peasant farms.

The interviewees stated that the conservation of forest patches serves several purposes, among which the supply of resources stands out, including construction materials (wood, broad leaves and vines), firewood, plants for medicinal and food use, etc., as well as protecting water resources (Table 2: Lc, Agni, Agpi, Lci). In terms of the water resources, forest conservation actions are carried out to protect water in 79.5% of the peasant farms, while this percentage was somewhat lower in the indigenous farms (68.8%, Table 2: Lc, Tag, Tam, Agni, Agpi, Lci). Regarding biological connectivity, 50% (n = 30) of all farms analysed were located within the 3 existing biological corridors in the study area: 2 in the “Bosque de Agua” Biological Corridor, 16 in the “Fuente de Vida La Amistad” Biological Corridor, and 12 in the “Río Cañas” Biological Corridor. According to the National Program of Biological Corridors, a biological corridor is a delimited continental, marine-coastal, and insular territory, whose primary purpose is to provide connectivity between protected wild areas; as well as between landscapes, ecosystems and natural or modified habitats, whether rural or urban, to ensure the maintenance of biodiversity and ecological and evolutionary processes; providing spaces for social agreement to promote investment in the conservation and sustainable use of biodiversity in those spaces [46]. In this way, the purpose of biological corridors is to promote conservation, beyond protected wild areas, from a functional and structural ecosystem connectivity

perspective. Although, all the farms located within a biological corridor were peasant farms, the indigenous farms are characterized by the conservation of continuous natural areas because they represent not only a source of ecosystem services but also cultural, spiritual and symbolic values.

In addition, 55 of the farms employed forest conservation, 26 (47.3%) of which (10 peasant farms and 16 indigenous farms) kept them under the Payment for Environmental Services regime, a state mechanism [54–56] that offers economic recognition for the environmental services provided by forest owners (Table 2: Lc, Tam, Lci).

3.2. Dimensions of the Agrosystems

3.2.1. FF Farm Management

The management system most often implemented was the agrosilvocultural system (63.3%, 38 plots), evident at 36 peasant farms and 2 indigenous farms. This was followed by the traditional indigenous polyculture system (23.3%, 14 plots), all of which were indigenous farms located in the three territories of the Bribri and Cabécar ethnic groups. The silvopastoral (6.6%, 4 plots) and agrosilvopastoral systems (6.6%, 4 plots) were those least often implemented in the management at the peasant plots, and they were completely absent at the indigenous farms (Table 3). A preference on the use of agrosilvocultural and polyculture systems shows a tendency towards to the agriproductive diversification by both peasant and indigenous agriproducers.

Table 3. Management systems implemented.

Management Systems	Number of FF Farms		
	Indigenous	Peasant	Total
Agrosilvocultural	2	36	38
Silvopastoral	-	4	4
Agrosilvopastoral	-	4	4
Polyculture	14	-	14
Total	16	44	60

Source: generated by the authors.

3.2.2. Product Diversification

Product diversification refers to the variation in the perennial and seasonal crops produced at the farms, and there were no significant differences between the peasant and indigenous plots. The vast majority (95%) of the peasant farms produced between 6 and 20 agricultural products simultaneously, while this proportion was somewhat lower in the indigenous farms (87.5%: Figure 5). This product diversity is the result of growing different crops simultaneously at the farm (vegetables, legumes, tubers, fruit trees and coffee), as favoured by the nonseasonal climate in this tropical zone. Some of the crops on these farms (basic grains: corn, beans and rice) are produced through intercropping, following two to three annual harvest cycles.

As showed in Figure 5, the low diversification identified in both systems, peasant and indigenous, was mainly related to the less work effort in the plot management due to a growing trend in the agriproducers to engage in paid activities, including work as agriculture labourer in the regional industrial agriproduction or for other local agriproducers. This tendency mainly affects the peasant agriproducers.

With regards the types of crops grown, musaceae were grown in 100% of the indigenous and peasant farms. Tubers were grown at all indigenous farms (100%) and at 86.4% of peasant farms., whereas basic grains, fruits, vegetables and legumes that were grown in 100% of the indigenous FF farms were only found at 45% of the peasant FF farms (Figure 6, Table 2: Tag, Agni, Agpi). Interestingly, there was very uneven cultivation of coffee, which was produced at 48% of the peasant farms analysed compared to 13% in the indigenous farms (Figure 6).

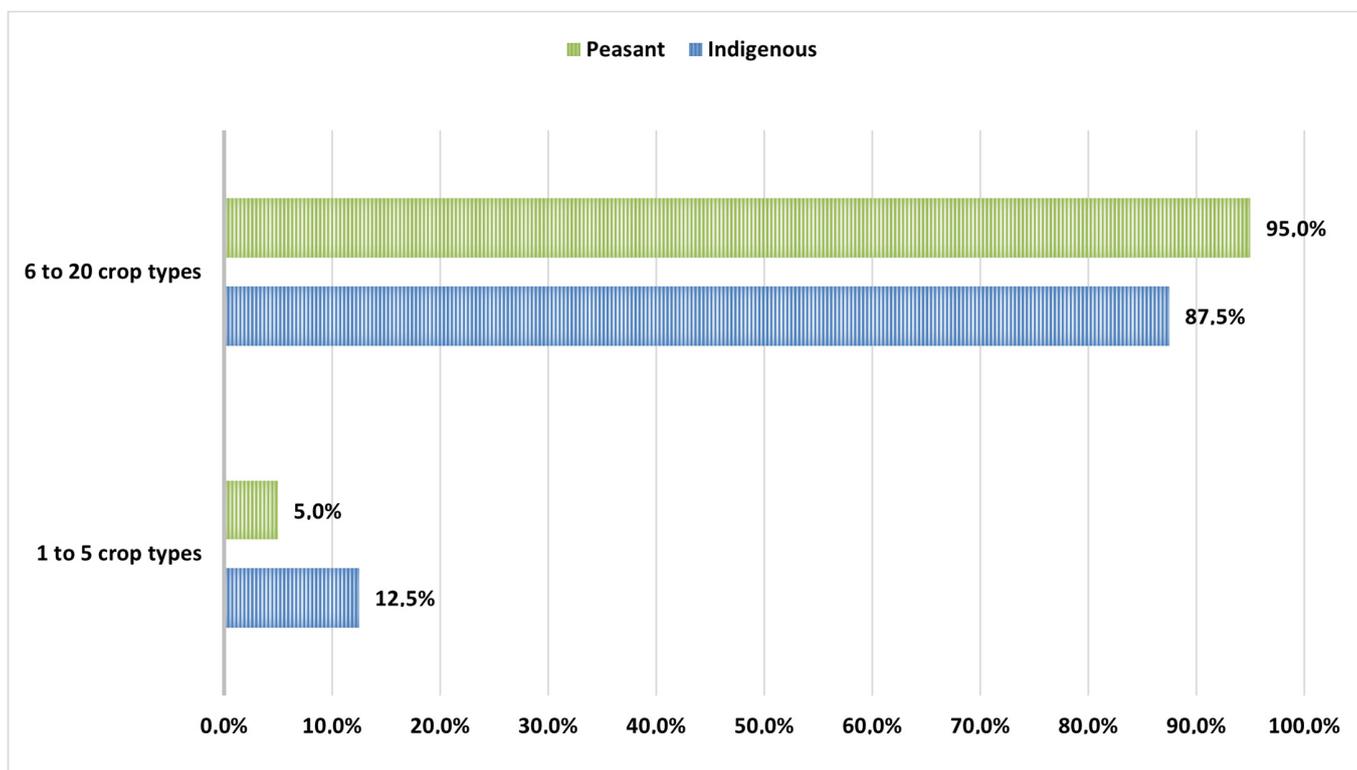


Figure 5. Product diversification in peasant and indigenous farms. Source: generated by the authors.

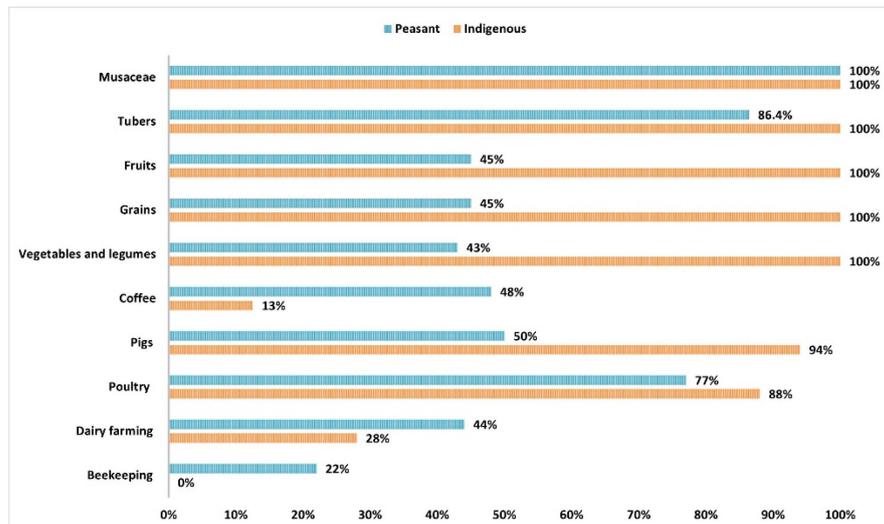


Figure 6. Product diversification in FF farms. Source: generated by the authors.

In terms of animal production (Figure 6), pig and poultry breeding was found at 94% and 88% of the indigenous farms, respectively, and at 50% and 77% of the peasant farms, respectively. Cattle breeding was practised at 44% of the peasant farms and at 28% of the indigenous farms. Beekeeping was only practised at 22% of the peasant farms (Table 2: Tag, Lci, Agpi).

3.2.3. Characteristics of the Family Nucleus

The analysis of the family nucleus showed that the peasant had an average composition of 4.9 members and the indigenous family unit had an average of 5.2 members. In both types of family units, the average adult population was higher (3.9 peasant adults and

3.2 indigenous adults) than the child population (one minor peasant and two indigenous minors on average). These values reveal a relationship of 3.9 adults per child in the peasant family unit and of 1.6 adults per child in the indigenous family unit. In 87.5% of the family units analysed, the adults were the parents and mature children. In the remaining 12.5%, the adult composition was comprised of single mothers who were the head of household and their young adult children, although it was more common that the father was the head of the household in both the peasant and indigenous family models. On the other hand, no ageing adults were identified in the peasant and indigenous family units analysed. It was estimated that 63.4% of the members of the family nucleus participate in the management of the farm.

3.3. Commercialisation in the Multifunctional Agrifood Systems

3.3.1. Focusing on High Market Value Products

Of all the farms sampled, 23 produced coffee and 22 of these were peasant farms whose owners indicated that it is the crop that provides the best revenue generator (Table 2: Lc, Ac, Tag, Agni). Coffee was only produced at one indigenous farm, found in the Bribri of Cabagra indigenous territory. In this regard, four associations of coffee producers were identified (one in Volcán, one in Potrero Grande and two in Biolley), which indicated that their main activities are the small-industry processing, distribution and sale of local coffee as a finished product. The coffee produced by the 22 non-indigenous peasant farms is marketed through the producer's associations (Table 2: Tag, Lc). The coffee that was produced in Cabagra is currently processed using very rudimentary artisanal techniques and is destined for on-farm family consumption, without any projections for commercialisation due to the lack of local infrastructures for its processing (Table 2: Lci, Agpi).

Several limitations were identified that make it difficult to establish a market for local products, especially those related to the availability of adequate road infrastructure and one of these limitations is the lack of transportation alternatives. Only 21% of the productive units characterized had a motorized vehicle, which were all peasant farms. In addition, the state of the roads, the geographic distance to the Great Metropolitan Area, which is the socioeconomic and commercial center of the country, and the deficiencies in telecommunications also influenced the commercialisation of the products (Table 2: Ac, Tag, Tam, Lc, Lci).

3.3.2. Short Food Supply Chains (SFSCs)

With regards the local marketing channels, the Buenos Aires Farmer's Market was identified as the only option, where 10 of the farms studied offer their products (7 peasant and 3 indigenous farms). All the products that are grown on the diversified farms (up to 20) are marketed at this agricultural fair. While it is true that this allows agriproducers to place their products directly in the urban centre of the town, it means they often incur transportation costs for their products that, given the distances involved (minimum distance Brunka to Buenos Aires 17.3 km or ca. 20 min; maximum distance Biolley to Buenos Aires 63 km or ca. 1 h 26 min), the rural road conditions and the fact that only 21% of the farms had a motorised vehicle, the possibilities of producers attending this market are limited (Table 2: Lc, Agni, Agpi). In this sense, transportation and road connectivity constraints negatively impact the efficiency of marketing agricultural products and therefore the economy of families, as well as the general living conditions of family farmers, such as access to health and education services (Table 2: Tmu).

3.4. The Governance of Territorialized Food Systems in the South Pacific

3.4.1. Engagement with the Community-Based Associations

Up to 47 community-based organisations were identified, their activities establishing a platform to support and strengthen the multifunctional agrifood systems and to offer alternatives for product commercialisation (Table 4).

Table 4. The platform of the community base associations.

Level	Organisation Type	District												
		Volcán		Brunka		Buenos Aires		Potrero Grande		Biolley		Total		
		C	I	C	I	C	I	C	I	C	I	C	I	
1	Territorial network (Quercus)													1
2	Development platforms	3	-	3	-	3	2	3	1	4	-	16	3	
3	Producer associations	Mixed *	1	-	2	-	1	1	2	-	1	-	7	1
		Women	-	-	1	-	1	-	1	-	2	-	5	-
	ASADAS **	2	-	2	-	1	2	3	2	2	-	10	4	
Subtotal		6	0	8	0	6	5	9	3	9	0	38	8	
TOTAL														47

* Composed of both men and women. I, Indigenous farms; C, Peasant farms; ** ASADAS, Administrative Associations of the Communal Aqueducts and Sewerage Systems. Source: generated by the Authors.

The first level of management is made up of one network whose territorial scope includes the entire municipality of Buenos Aires (Red Quercus). It is comprised of an Association for the Integral Development of the Biolley District (ADI Biolley) and four producer associations: Association of Organized Women of Biolley (ASOMOBI); Santa María de Brunca Chamber of Tourism Association (ACETUSAMA); Women's Supporting Harmony with Nature and the Environment for the Well-Being of Families (AMANABIF); and the Fila Piedras Blancas Association of Producers and Marketers (APROCOME). In addition, this network has also established cooperation agreements with three ASADAs (Administrative Associations of the Communal Aqueducts and Sewerage Systems): The Administrative Association for the Volcán Rural Aqueduct; the Administrative Association for the Piedra Convento Rural Aqueduct; and the Administrative Association for the Gutierrez-Braun Rural Aqueduct. This network fosters the strengthening of the different territorial organisations, and it provides them with support on issues related to conservation through educational activities related to sustainable development (Table 2: Lc). The Buenos Aires Farmer's Market is managed through the Quercus Network, allowing them to maintain a local marketing channel where the consumer purchases agricultural products directly from the producer.

At the second management level, 19 Community and Integral Development Associations were identified, of which 3 corresponded to each of the three indigenous territories. The primary objective of these associations is the integral development of the territory (Table 2: Tmu, Lc, Lci). At the third management level, a total of 27 associations were identified that could be differentiated into two categories:

- Producer associations, aimed at the sustainable development of the traditional agri-food systems, the conservation of biodiversity and the promotion of the region's agrolandscape values, carry out activities linked to rural community-based tourism. A total of 13 associations of this type were identified, of which 7 are mixed (made up of men and women) and only 1 was composed of indigenous farmers (in the Salitre indigenous territory). Moreover, five women's associations were identified, all of them composed of peasant farmers and none of indigenous farmers.
- Associations for water resources management (Administrative Associations of the Aqueducts Systems -ASADAS), whose aim, besides providing drinking water to local communities, is to ensure the protection of water and indirectly, of forests. There were 14 ASADAS identified, 10 of which were at peasant farms and 4 at indigenous farms. These differences could be explained by cultural issues, given that the indigenous groups are characterised as less likely to be associated with community-based organisations to obtain a water supply and for the management of water resources, as opposed to the peasant population for whom water management is very rele-

vant, especially in peripheral regions. Other aspects of the indigenous settlements in the Ujarrás and Cabagra territories could be related to these differences because the settlements of this population are dispersed across the upper parts of the basins, which makes the organisation of community aqueducts difficult. In addition, these indigenous people traditionally obtain their water from wells close to their homes (Table 2: Lc, Tam, Tmu, Lci, Agpi, Agni).

3.4.2. Land Tenure

Of the total FF farms characterised, 20 (33.3%) had problems associated with land tenure, due to the fact that the population does not hold land titles. Of the 20 farms in which problems were detected, 4 corresponded to peasant farms and the remaining 16 correspond to indigenous farms, all of which are inventoried indigenous plots. This fact is related to historical–cultural issues because the land included within the legally established indigenous territories is of communal and not individual ownership [44], (Table 2: Ac, Tag, Tam, Agpi, Lci). It was concluded that the lack of a land title in 20 of the farms analysed (4 peasant and 16 indigenous farms) is a critical factor that limits the farmers' access to bank credit, an alternative to invest capital in improving the management of the production unit (Table 1: Lc, Ac, Tag, Agpi, Agni). In this regard, the 2018 report of the Central Bank of Costa Rica on the access of micro, small and medium production units to financial services indicates that the use of banking services by the Costa Rican peasant and indigenous population is 64% and 50%, respectively. Indeed, applications for credit to the state bank by the peasant population accounted for 32% of the transactions. In the case of the indigenous population, the applications for credit did not exceed 5%, and the lack of mortgage guarantees was the main barrier to bank loans in both cases [57].

Table 5 below summarizes the most relevant results that have emerged from this analysis.

Table 5. Summary table of results.

Parameter/Unit	Peasant	Indigenous
Average plot area (hectares)	4.6	2.1
Average plot altitude (meters)	904.1	653.8
Plots perimeters (number)	3	2
Forest conservation area (percentage of the plot)	25.2	39.7
Species in the tree–shrub stratum of the plots (number)	14.1	18.6
Threatened species (presence/absence)	presence	presence
Vulnerable species (presence/absence)	presence	presence
Protection of water resources by forest conservation (percentage of each type of plot)	79.5	68.8
Plots within a biological corridor (number)	30	0
Plots under Payment for Environmental Services regime (number)	10	16
Plots under Agrosilvocultural system management (number)	36	2
Plots under Silvopastoral system management (number)	4	0
Plots under Agrosilvopastoral system management (number)	4	0
Plots under Polyculture system management (number)	0	14
Plots with 6 to 20 crop types (percentage of each type of plot)	95	87.5
Plots with 1 to 25 crop types (percentage of each type of plot)	5	12.5
Cultivation of musaceae (percentage of each type of plot)	100	100
Cultivation of tubers (percentage of each type of plot)	86.4	100
Cultivation of basic grains, fruits, vegetables and legumes (percentage of each type of plot)	45	100
Cultivation of coffee (percentage of each type of plot)	48	13

Table 5. Cont.

Parameter/Unit	Peasant	Indigenous
Plots with pig breeding (percentage of each type of plot)	50	94
Plots with poultry breeding (percentage of each type of plot)	77	88
Plots with cattle breeding (percentage of each type of plot)	44	28
Plots with beekeeping (percentage of each type of plot)	22	0
Average composition of family nucleus (number of members)	4.9	5.2
Average adult population of family nucleus (number of adult members)	3.9	3.2
Average minor population of family nucleus (number of minor members)	1	2
Average of ageing adults of family nucleus (number of ageing members)	0	0
Participation of the members of the family nucleus in the management of the farm (percentage of each type of plot)	63.4	63.4
Plots that own a motorized vehicle (percentage of each type of plot)	21	0
Plots that sell their products in Buenos Aires Farmer's Market (number of plots)	7	3
Territorial network (Quercus) (presence-absence)	presence	presence
Development platforms (number of platforms)	16	3
Producers associations (number of associations)	12	1
Associations for water resources management (number of associations)	10	4
Plots with problems associated with land tenure (number of plots)	4	16

Source: generated by the authors.

4. Discussion

4.1. The Environmental Bases and General Characteristics of Family Farming

While, in the region studied, peasant and indigenous peasant family farms coexist, these differ in both their historical and cultural origins, as well as in other aspects derived from state agricultural policies [50,58]. With respect to the differences in the size of the FF exploitations, this appears to be related to the model of distributing land by the state since the 1970s, granting land to the settlers in the region to whom lots between 3 and 5 ha were allocated for agriculture. By contrast, in the case of the native population, the passing of the Law of the Indigenous People (No. 6172) in 1977 left the division of the land in the hands of the local indigenous governments in each region, which usually meant that each family received a lot between 0.5 and 2 ha, as occurred in other countries in Latin America [59].

The system of agricultural and the cattle exploitation characteristic of the agrarian landscapes in this part of Central America demonstrate the intense interest in the normal practice of conserving patches of forest and other green areas within the lots, such as tree-fenced areas [60–64]. In the South Pacific region of Costa Rica, peasant and indigenous agricultural systems play an important ecological role thanks to the conservation of patches of woodland within the productive family lots, given that they act as a connective biological link between many fragments and counteract the isolating effect of intermediate agricultural terrains [65]. This practice also provides benefits regarding the protection of water resources, such as improving the flow and quality of the water [66,67], while riverbank vegetation helps regulate ecological processes in waterways and their associated habitats [68].

The productive exploitation of peasants and indigenous highlight the interest in maintaining the tree canopy under different circumstances, such as agrosilvicultural, silvopastoral, agrosilvopastoral and, especially, the native polyculture system, providing a notable ecological effect in the buffer zone of the PILA and its biological corridors [69]. The figure of conservation of biological corridors does not prevent access to natural resources and biodiversity whenever it is a sustainable use, according to environmental laws; therefore, the existence of corridors does not negatively affect peasant and indigenous productive activities but rather promotes their integration with conservation [46]. The

greater woodland coverage in the indigenous exploitations than in the peasant exploitations is not due to the existence of a biological corridor but can be attributed to the fact that the 3 native territories of interest, and hence the 16 peasant lots analysed, fall within the system of woodland incentives of the Payment for Environmental Services regime. However, regarding the peasant's exploitations, 30 of the 44 sampled are located within a biological corridor in the area studied, such that their contribution to the objectives of connectivity and sustainability for the productive use in the corridors is fundamental [46]. By contrast, and from the point of view of the landscape, the diverse farm owners can act as conservationists by creating a landscape that is a matrix of productive systems that facilitate an ecological flow and that contributes to halting the advance of agricultural front towards natural protected spaces, which at the same time gives rural communities a sustainable and noble base [7,10,70]. This perspective of sustainable landscape management is being recognized in different parts of the world, where family farmers play a leading role [71–73].

4.2. The Management Systems and Productive Diversification as a Resource for Socioambiental Resilience

Latin America possesses about 15 million FF exploitations, of which about 65% are managed by small holders, many of whom are poor and ever more dependent on incomes other than those generated by agriculture to survive [22,74]. Although reduced, the income from this productive model is absolutely critical for their survival and to buffer their vulnerability [74].

Biodiverse agricultural terrains are ever more common, in which the land dedicated to agriculture is intercalated with woods, plains and wetlands, replacing the large monoculture extensions [22,75]. The agricultural systems that maintain greater biodiversity and that are managed with fewer resources, such as those based on FF, demonstrate more ecological benefits associated with their biodiversity [19,20,22,74,76]. The opposite occurs with simpler systems that are sustained by more resources, such as agro-industrial monocultures [77,78]. Variation in the sequence of crops, both spatially and temporally, is a factor that defines the heterogeneity and diversity of the agricultural landscape [79]. This is particularly relevant in tropical agricultural terrains that are configured as a mosaic of crops (with heterogeneous management strategies), intercalated with small woodlands or forests [5,10]. Some particular qualities are associated with the productive systems analysed. For example, by managing areas of woodland the peasant agricultural system contributes to the structural and biological connectivity within biological corridors. In addition, the indigenous systems of production that incorporate woodlands as part of their agroproductive development also provide diverse services to ecosystems. In both these cases, the state participates significantly by providing incentives, such as the system of Payment for Environmental Services [56]. The regime has been administered by the National Forestry Financing Fund and has been widely considered the most successful application of the environmental services approach worldwide. The program currently compensates forest owners for three conservation activities: natural forest conservation, reforestation and agroforestry [55].

Unlike industrial monoculture, many of the traditional farming systems are characterized by diverse types of management that improve the functional biodiversity of the crops and that also provide benefits to the agroecosystem in terms of resilience [80,81]. The use of multiple varieties of crops offers advantages, such as guaranteeing intra- and interspecies diversity, and thereby improving the security of the crop harvests. The most resilient crops, and those least vulnerable to pests and disease, as well as those that resist the stress caused by climatic conditions, have a lower variability in terms of production, which is associated with a smaller social and economic risk to the farmers [72,82,83]. This topic has been studied, especially in the context of climate change, in different regions of developing countries, where FF persists [84,85].

The diverse agroecosystems retain their organization and productivity after perturbation, given that they have the capacity to resist or recover from certain environmental changes [5,81]. Coupling agricultural intensification to the management and use of re-

sources, and to the worldwide productivity and safety of foodstuffs, is maybe a means to reduce the expansion of agriculture at the cost of natural ecosystems [86]. In this regard, the state has played an ambiguous role because on the one hand, it has promoted pro-conservation programs such as Payment for Environmental Services, while on the other hand, it has encouraged the expansion of industrial crops in the agriculture export policies framework, with its known socioenvironmental implications [23,87]. Despite this, the FF model of agricultural exploitation in the South Pacific, as well as its high degree of diversification, possesses a series of attributes that have allowed it to adapt to the impact of the expansion of industrial pineapple crops in the municipal area of Buenos Aires [21] (León et al., 2019). In this sense, the potential productivity of the South Pacific should pay attention to the increasing pressure on its natural resources and to the risk that this poses to those that depend on FF exploitations [88].

4.3. Commercialisation and Production with Added Value

Currently, in the South Pacific, around 12,000 ha are dedicated to the cultivation of coffee [89]. However, the fluctuations in the price of the bean, the diseases that affect its production, and the problems associated with its commercialisation, mainly due to the limitations associated with transportation, have led local producers to produce lower quantities that have greater overall value. Coffee is the only local product that has been possible to commercialise directly in Central American markets thanks to the platforms that are available to the associations of producers [90]. The connectivity in the South Pacific region is only 15.46%, with the municipality of Buenos Aires having one of the worst connectivity rates in Costa Rica (8.2%) [91,92]. This lack of connectivity, due to the poor state investment in telecommunications, makes it virtually impossible to contact with the producers from outside the country through internet, and even phone communication is less than adequate in most of the area studied.

In the past decades, the structures that formed the basis of the communal associations have been converted into a platform that enables the small producer, and in particular the peasants, to come together and take advantage of the options to improve both their production and their socioeconomic status. However, it has not been possible to consolidate a long-term model of favourable and stable socioeconomic development that converts the FF into an attractive way of life for younger generations, ensuring they remain in these regions and reducing the demographic imbalance that they currently face. The poor access to bank credits, and to a funds aimed at stimulating investment and improvements in production, is the most negative factor for FF. This limits the possibilities of potentiating activities orientated towards improving production and commercialisation, making it harder and often impossible for the small farmer to enter local and regional markets [57]. In this sense, it is fundamental to strengthen the efforts of the productive farmers by facilitating their access to credit and investment by improving telecommunications, by enhancing and establishing new routes of commercialisation, and through the development of new marketing strategies that include the implementation of regional seals of quality, product diversification (with added value), and the implementation of new business models, such as that of rural tourism [93,94].

4.4. Strong Governance of an Agrifood System in a Peripheral and Border Region

The historical abandonment of the South Pacific region by state institutions [21,23,95] is clearly evident in the poor roads and in the lack of endogenous socioeconomic development policies that favour the commercialisation of the products from the multifunctional agrifood systems in this region [23]. The lack of institutional leadership in peripheral and border regions like the South Pacific [87], together with strong association and respect for the environment, has enabled the inhabitants of the foothills of the Talamanca Mountain Range to develop a spirit of cooperation and corporatism, which has favored the establishment of a very solid base of community associations since the 1980s [58]. It is quite striking that in a territory of this size, so removed from the governing institutions, up to 47 community-based

organisations exist of diverse nature, yet all with a shared vision of conservation-based local development, favouring the maintainance of the traditional ways of life and regional values regarding the rural lands [23].

Despite the considerable associative and organisational capacity of family farmers, the aspect of governance relating to land tenure is revealed to be a worrying factor. Outside the indigenous territories, this problem is associated with untitled agricultural plots, mainly due to their location within State Natural Heritage areas. This is the case of the La Luchita settlement in the Potrero Grande district in which 75% of the plots are affected because they are located in sites of such a Natural Heritage category [96]. Problems related to land tenure make it impossible for agricultural producers to access bank mortgage loans, as well as some subsidies and stimulus packages aimed at improving agricultural production. In this context, the options of family producers to obtain the financial capital necessary to innovate and improve their farm's production and commercialisation are greatly reduced [57]. On the other hand, communal land tenure in indigenous territories provides a safeguard for ethnic groups and their cultural practices, yet at the same time, it has been recently seen to pose a major impediment to obtain individual bank loans [97].

Taking into account that the municipality of Buenos Aires has close to 1500 linear km of rural roads, the efforts of local governments have historically been focused mainly on maintaining the road infrastructures as a key element for regional socioeconomic development. Thus, less emphasis has been placed on resolving other problems associated with local development and, in particular, those related to the behaviour of the industrial agriproduction model. This has favoured the emergence of a variety of organisations, especially producer associations, which have attained a very important role as actors in local and regional governance [23].

Both peasant and indigenous agrifood systems participate in the management of agrobiodiversity, based on traditional knowledge and on the interests of maintaining environmentally sustainable practices. However, they do differ in aspects related to commercialisation and associativism (Table 5). Moreover, the experience of peasant groups in terms of self-governance and the marketing of agricultural products could be a replicable model for the indigenous population. In any case, both production systems based on FF constitute an essential element for the future construction of multifunctional agricultural landscapes in a region that faces a series of dynamics and territorial processes—hence the need to deepen its knowledge in an integrated manner, by different academic fields and between them and farmers [98].

5. Conclusions

Based on the results of the present study, the family farming-based Agrifood Systems in the South Pacific region of Costa Rica may be a key element to curb the advance in recent years of an environmentally and socially unsustainable agroindustry. Traditional indigenous systems have been able to conserve natural resources, especially forest resources, while new peasant agriculture systems, yet to be consolidated, follow a diversified system that respects natural resources capable of developing healthy and sustainable agricultural production. In addition, basic self-governance has developed in this sector in a singular and original way, with a strong potential to turn these systems into key territorial pieces for the future [98]. The institutional vacuum experienced by this peripheral border region, which has been repeatedly denounced, has been replaced by the democratic, participatory and solidarity activities of the indigenous and peasant population in this Central American setting, united around agricultural and livestock production [86].

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Appendix A

Table A1. Trees and shrubs present in the FF production units.

Family	Species	Presence	Uses
Anacardiaceae	<i>Anacardium excelsum</i>	5	Timber
	<i>Anacardium occidentale</i>	6	Food
	<i>Mangifera indica</i> *	6	Food
	<i>Spondias purpurea</i>	5	Food
	<i>Tapirira myriantha</i>	1	Food
Annonaceae	<i>Annona muricata</i>	5	Food
Annonaceae	<i>Annona squamosa</i>	5	Food
Araliaceae	<i>Guatteria chiriquiensis</i>	2	Forest coverage
	<i>Sciadodendron excelsum</i>	4	Forest coverage
Arecaceae	<i>Bactris gasipaes</i>	4	Food
	<i>Prestoea acuminata</i>	4	Food
Bignoniaceae	<i>Spathodea campanulata</i> *	6	Timber
	<i>Tabebuia guayacan</i>	3	Timber
	<i>Tabebuia ochracea</i>	8	Timber
	<i>Tabebuia rosea</i>	1	Timber
Bixaceae	<i>Bixa orellana</i>	1	Food
Burseraceae	<i>Protium costaricense</i>	4	Timber
Calophyllaceae	<i>Mammea americana</i>	1	Food
	<i>Calophyllum brasiliense</i>	7	Timber
Caricaceae	<i>Jacaratia dolichaula</i>	4	Forest coverage
Combretaceae	<i>Terminalia amazonia</i>	10	Timber
Cordiaceae	<i>Cordia bicolor</i>	4	Timber
Euphorbiaceae	<i>Alchornea latifolia</i>	5	Timber
	<i>Cnidoscolus aconitifolius</i>	2	Food
	<i>Croton draco</i>	5	Medicine

Table A1. Cont.

Family	Species	Presence	Uses
Fabaceae	<i>Cajanus cajan</i> *	4	Food
	<i>Cassia fistula</i>	3	Forest coverage
	<i>Cojoba arborea</i>	6	Forest coverage
	<i>Diphysa americana</i>	7	Timber
	<i>Enterolobium cyclocarpum</i>	4	Timber
	<i>Enterolobium schomburgkii</i>	1	Timber
	<i>Erythrina poeppigiana</i> *	6	Agricultural
	<i>Gliricidia sepium</i>	6	Agricultural
	<i>Hymenaea courbaril</i>	3	Food
	<i>Inga edulis</i>	9	Food
	<i>Samanea saman</i>	1	Timber
	<i>Senna reticulata</i>	5	Medicine
	<i>Senna spectabilis</i>	5	Medicine
<i>Zygia longifolia</i>	4	Forest coverage	
Humiriaceae	<i>Humiriastrum diguense</i>	3	Timber
Hypericaceae	<i>Vismia baccifera</i>	7	Timber
Lamiaceae	<i>Gmelina arborea</i> *	3	Timber
Lauraceae	<i>Beilschmiedia anay</i>	1	Food
	<i>Laurus nobilis</i> *	2	Medicine
	<i>Persea americana</i>	8	Food
Malpighiaceae	<i>Byrsonima crassifolia</i>	7	Timber
Malvaceae	<i>Goethalsia meiantha</i>	5	Forest coverage
	<i>Ochroma pyramidale</i>	4	Timber
	<i>Theobroma cacao</i>	3	Food
Melastomataceae	<i>Blakea gracilis</i>	6	Forest coverage
	<i>Conostegia xalapensis</i>	5	Forest coverage
	<i>Miconia argentea</i>	6	Forest coverage
Meliaceae	<i>Cedrela odorata</i>	7	Timber
Moraceae	<i>Artocarpus communis</i>	4	Food
	<i>Artocarpus heterophyllus</i>	4	Food
	<i>Ficus citrifolia</i>	5	Forest coverage
Myristicaceae	<i>Virola koschnyi</i>	9	Timber
Myrtaceae	<i>Myrcianthes fragrans</i>	5	Timber
	<i>Psidium friedrichsthalianum</i>	2	Food
	<i>Psidium guajaba</i>	6	Food
	<i>Syzygium jambos</i>	5	Food
	<i>Syzygium malaccense</i>	6	Food
Oxalidaceae	<i>Averrhoa carambola</i>	2	Food
Phyllanthaceae	<i>Hyeronima alchorneoides</i>	8	Timber
Rutaceae	<i>Citrus aurantifolia</i> *	6	Food
	<i>Citrus limetta</i> *	5	Food
	<i>Citrus sinensis</i> *	6	Food
	<i>Zanthoxylum melanostictum</i>	1	Timber
Salicaceae	<i>Casearia arborea</i>	3	Forest coverage
Sapindaceae	<i>Melicoccus bijugatus</i> *	4	Food
Sapotaceae	<i>Pouteria sapota</i>	2	Food
Simaroubaceae	<i>Simarouba amara</i>	5	Medicine
Urticaceae	<i>Cecropia peltata</i>	6	Forest coverage
	<i>Pourouma minor</i>	5	Forest coverage
Vochysiaceae	<i>Vochysia guatemalensis</i>	7	Timber
Zygophyllaceae	<i>Guaiacum officinale</i>	2	Timber

* Exotic species. Source: generated by the authors.

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