forests

MDPI

Article

Indigenous Family Labor in Agroforestry Systems in the Context of Global Transformations: The Case of the *Inga* and *Camëntsá* Communities in Putumayo, Colombia

Vandreé Julián Palacios Bucheli [1,2], Robert Williams Cárcamo Mallen [2], Adolfo Álvarez Macias [3], Claudia Coral [2,*] and Wolfgang Bokelmann [2]

1 Master Program on Tropical Agroforestry, Universidad de Ciencias Aplicadas y Ambientales U.D.C.A, Bogotá 111166, Colombia; vpalacios@udca.edu.co
2 Department of Agricultural Economics, Humboldt Universität zu Berlin, 10117 Berlin, Germany; carcamor@hu-berlin.de (R.W.C.M.); w.bokelmann@agrar.hu-berlin.de (W.B.)
3 Neurophysiology, Behavior, and Animal Welfare Assessment, Xochimilco Campus, Department of Animal Production and Agriculture (DPAA), Universidad Autónoma Metropolitana (UAM), Mexico City 04960, Mexico; aalvarez@correo.xoc.uam.mx
* Correspondence: claudia.coral@hu-berlin.de; Tel.: +49-(0)30-2093-46340

Abstract: The *Camëntsá* and *Inga* indigenous communities still rely on agroforestry systems for their livelihood attainment, although globalization effects have also reached their settlements. Agroforestry systems, especially home gardens, are experiencing reduced size and species diversity and therefore gradually disappearing. This research aims to determine the indigenous family labor contribution to agroforestry systems as a strategy to secure their livelihoods. The methods include a census, household survey, interviews with key informants, and direct observation. Family labor contributes to reducing production costs in agroforestry systems. Three groups of households were identified from the cluster analysis to determine the family labor contribution: smaller, medium-sized, and larger farms. The smaller farms register better economic indicators compared to the other two groups. In addition, they show a positive cost–benefit ratio and profitability, which is explained by lower production costs compared to the gross income generated. Although larger farms have higher gross revenues, these households also assume higher production costs and incur higher input costs. Medium-sized farms face the worst scenario. There is a relationship between the use of family labor and the achievement of livelihoods related to economic indicators and biodiversity and the variety of species harvested on farms and used for self-consumption. Family labor helps to ensure local food security and generate income.

Keywords: agrisilvicultural; agrosilvopastoral; biodiversity; socioeconomic transformations; silvopastoral

Citation: Palacios Bucheli, V.J.; Cárcamo Mallen, R.W.; Álvarez Macias, A.; Coral, C.; Bokelmann, W. Indigenous Family Labor in Agroforestry Systems in the Context of Global Transformations: The Case of the *Inga* and *Camëntsá* Communities in Putumayo, Colombia. *Forests* **2021**, *12*, 1503. https://doi.org/10.3390/f12111503

Academic Editor: Luis Diaz-Balteiro

Received: 9 August 2021
Accepted: 26 October 2021
Published: 30 October 2021

1. Introduction

The relevance of "local" knowledge arising from the practices of indigenous agroforestry may be highly relevant for addressing multiple and converging global crises and thus improving climate change mitigation actions, food production, and resilience [1]. The knowledge and benefits are not only limited to particular localities [1]. However, indigenous communities globally are experiencing profound transformations in their livelihoods and productive models because of a concatenation of multiple global processes such as urbanization, climate change, and migratory flows, among other relevant aspects [2–4]. It is increasingly common to observe processes of disintegration of indigenous communities due to the multiple effects of globalization (trade, capital flow, technology, labor, migration, policies, environment), limiting the maintenance of integral models of natural resource management and, therefore, encouraging the abandonment of diversified productive systems and their inherent multifunctionality and community identity [5,6]. Consequently, the complexity that has distinguished agroforestry systems tends to decrease, undermining

food self-sufficiency and employment strategies for all family members [5,6] to the extent that family labor needs are restricted. A migratory flow from indigenous areas to growing urban centers has been favored, mainly of the younger relevant population [2–4]. Similarly, the work assigned to women and children in production–consumption units gradually loses relevance; at the same time, in indigenous communities, there is a trend toward agricultural specialization that, in extreme cases, leads to the adoption of monocultures and livestock production [7]. Moreover, policies often encourage the increased use of cash crops, consequently leading to biodiversity decline [8]. For instance, in India policies have affected the sustainability of local cattle farming systems through the support of cross-breeding with European breeds for more than one decade, triggering the disappearance of local breeds [9].

Monoculture plantations have gradually increased, and, as a consequence, biodiversity has been reduced, which threatens cultural and traditional livelihoods. As a result, there is a specific shortage of family labor [10] and an increased reliance on hired labor, which has disrupted the organization of family labor. This situation has led to increased production costs and productive specialization [7]. In rural communities in many regions of the world, migration has increased, which is another driver eroding livelihoods [10] and environmentally friendly agriculture [11] such as agroforestry systems [12]. Labor outflow is concentrated among young people, who seek work and study opportunities in urban areas and often do not return to their community. Indigenous family labor in agroforestry systems has the potential to contribute to household livelihood [13].

However, the economic impacts of agroforestry are still poorly understood [14] under current globalizing conditions. This paper explores different agroforestry systems in the *Inga* and *Camëntsá* indigenous communities to determine the contribution of indigenous family labor in agroforestry systems to household livelihoods in the context of social and economic transformations.

The *Inga* and *Camëntsá* communities located in the Putumayo region of Colombia, which have modeled agroforestry systems over hundreds of years to ensure their survival, have not been exempt from globalization effects despite being geographically isolated. As a result, they have experienced agricultural specialization in the last six decades, and non-agricultural work has become necessary in villages close to urban areas.

Studies focusing on the organization of family labor in agroforestry systems are limited globally. Few studies have documented the relationship between socioeconomic and ecological dynamics in the *Camëntsá* and *Inga* communities. A study investigating the importance of home gardens for food security, based on a comparative assessment of agricultural systems, distinguished three modalities: traditional, market, and mixed [15]. Similar research has analyzed the importance of biodiversity for livelihoods, revealing that 50% of the families that participated in the study had adopted a peasant farming model following traditions that favor using and conserving natural resources [16].

A total of 128 species that help sustain the livelihoods of indigenous communities have been identified [16]. Agroforestry systems, especially home gardens, are vital to maintaining the *Inga* and *Camëntsá* culture. The home garden has been reduced in size and species diversity, which threatens its stability.

To address the reorganization of family work and its main implications for the *Inga* and *Camëntsá* indigenous communities of Colombia, we (i) characterize agroforestry systems in the study region, distinguishing their different modalities according to the organization of family work; (ii) identify and estimate the number of labor requirements for each agroforestry system in *Inga* and *Camëntsá* indigenous communities; (iii) estimate the economic participation of family labor in income generation; and (iv) characterize the most active groups of farming households in terms of income generation, labor dependency, and production of goods for indigenous families. We discuss these findings in the light of existing studies and draw implications for future research.

Study Area

The province of Putumayo is located in the southwest of Colombia, bordering Ecuador and Peru. The province was selected because of the overwhelming agrobiodiversity in the agroforestry systems. The Sibundoy Valley comprises two contrasting geographical regions: (i) the flat area covers about 8500 ha, with an average altitude of 2000 to 2100 m above sea level; and (ii) the surrounding mountainous area reaches 4000 m and covers approximately 55,453 ha [16]. The Sibundoy Valley comprises four municipalities: San Francisco, Sibundoy, Colón, and Santiago. The research was carried out in five villages in the municipality of San Francisco: (i) Central San Antonio, (ii) San Silvestre, (iii) La Menta, (iv) San Agustín, and (v) San José del Chunga (Figure 1). Authorization to carry out the fieldwork was obtained from the Cabildo Indígena *Camëntsá* e *Inga* of the municipality of San Francisco. One reason for selecting the study area was the willingness of key informants to share information about the households protecting the traditional family gardens and related data.

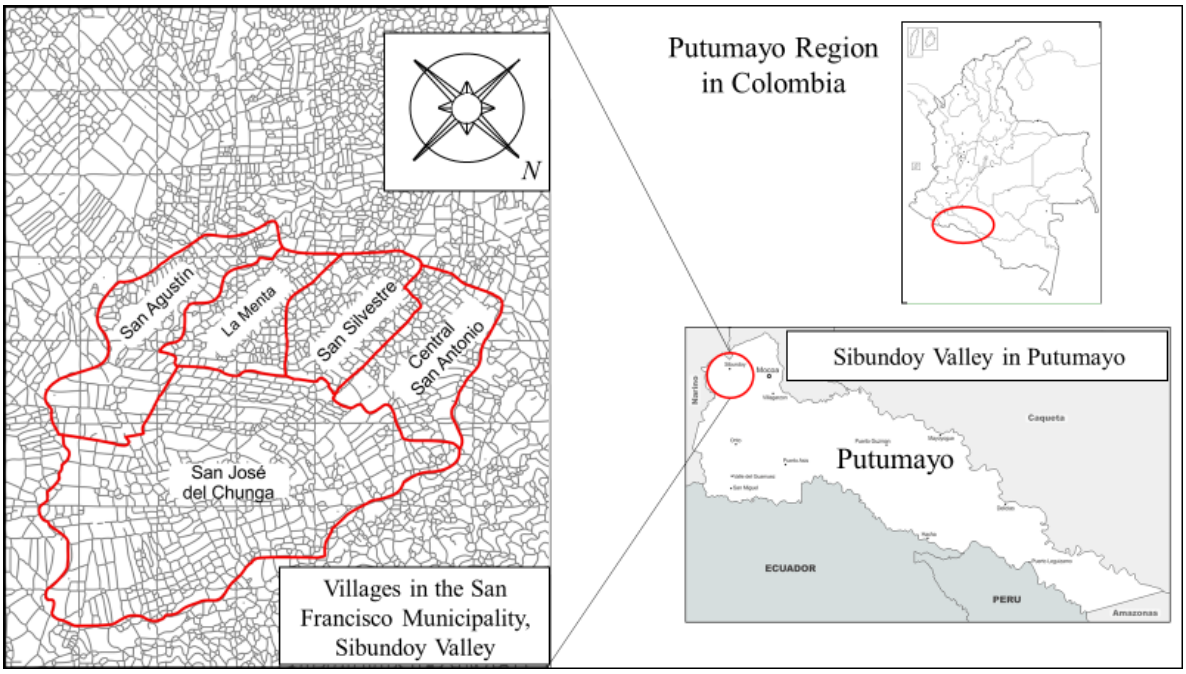

Figure 1. San Francisco municipality, Sibundoy Valley, Colombia.

The *Inga* and *Camëntsá* communities are embedded in a mountain ecosystem that provides goods and services and allows the development of diversified productive systems. Agrosilvopastoral, agrisilvicultural, and silvopastoral systems provide food, raw materials, and employment throughout the indigenous communities [17]. The high diversity of tree, shrub, herbaceous, and vine species characterizes these systems.

2. Materials and Methods

2.1. Data Collection Strategy

This research relied on mixed methods to comprehensively understand the study topic. We employed a census and a household survey to obtain quantitative data and key informant interviews combined with direct observation during field visits. The unit of analysis was the indigenous peasant family, considering its members, their work capacity, the surface area they own, and the diversity of plant and animal species produced and collected, including (i) the plots outside the five villages within the flat zone, and (ii) those located within the five villages of the Sibundoy Valley.

The indigenous peasant families showed various levels of complexity, ranging from landless households, those that resorted to leasing, to diversified farms with more than one

agroforestry system and/or natural forest. Economic activities, including agriculture, were associated with services and handicrafts, but only agricultural activities were considered for this study.

The census conducted in 2015 involved visiting all households in the five villages under study. The results were derived from a total of 146 households. The second round of data was obtained in 2016 from a targeted survey of a stratified random sample of 67 households, mainly in the villages of San Silvestre and La Menta (Table 1).

Table 1. Population and sample in the study area of the Sibundoy Valley.

Village	Population (2015)	Sample (2016)
San Silvestre	54	25
La Menta	48	21
Central San Antonio	20	8
San Agustín	13	6
San José del Chunga	11	7
TOTAL	146	67

The questionnaire that was applied to household heads comprised three items: (i) characterization of indigenous households; (ii) socioeconomic information; and (iii) environmental information. Direct interaction between the interviewer and the interviewee through face-to-face interviews facilitated obtaining accurate answers to the queries contained in the questionnaires. It was crucial to build trust with the population and thus gain access to key informants during the census and the survey. The questionnaires and their guidelines were translated into the national language. Direct field observation was essential to recognize the biodiversity of the agroforestry systems, which was organized along transects.

The main variables considered for this analysis included socioeconomic and environmental variables such as (i) household members, their ages, and their occupations inside and outside the household; (ii) the plant diversity of the farm; (iii) the harvest obtained in the agroforestry systems that was destined both for consumption and for sale for cash; and (iv) production costs (inputs, capital, services, and labor), for which both internal and external labor were considered.

2.2. Data Analysis

This research adopted an integrative analysis using a dependent, iterative, and reciprocal process combining qualitative and quantitative data. The integrative analysis included parallel conversion or sequential procedures [18]. Therefore, this research used cluster analysis as a robust tool for multivariate exploratory data analysis [19] because it was a convenient method for identifying homogeneous groups of family farms. Cluster variables shared characteristics and, at the same time, were different from variables in other clusters, which allowed for exploratory multivariate analysis. The resulting clusters of family farms were analyzed separately using descriptive statistics to obtain comparisons among household groups. Indicators for the analysis were: (i) the mean number of household members; (ii) the mean number of indigenous peasant family plant diversity, and; (iii) profitability and cost–benefit ratio.

For the environmental variables (biodiversity in family farms), similarities among farm households were estimated using the Roger and Tarimoto (1960) coefficient, which gives more weight to differences than to similarities [20]. For household agricultural production, as many of the goods generated for household consumption and trade as possible were valued. Four maize products were identified that a household could use: (i) seeds, (ii) dry grain, (iii) fresh grain, and (iv) leaf for fodder. The same was considered for other products from different agroforestry systems. A price was established through

key informants where information was not available for a product because it was not marketed (e.g., fodder for guinea pig, leaves from *Brassica oleraceae*). Local markets and shops in the head municipality of Sibundoy were other sources of information when the product's price was not revealed by the interviewee.

Production costs were divided into inputs, capital, services, and labor. Inputs included those produced internally, such as seeds saved from the last harvest and agro-ecological fertilizers produced by the farm, as well as those purchased externally. Depreciation was estimated for perennial crops and livestock inventory. For capital, internal and external items were included and depreciated. Being mostly communal, the land was not assumed for valuation unless a lease was incurred. Livestock services such as veterinary services were necessary and always considered an external cost. As for labor cost, all possible activities were considered because of their relevance to the management of the agro-ecosystem without considering the opportunity cost, as these were production units oriented more toward food security than to the search for maximum profitability. There were available job opportunities for the families in the urban areas in neighboring regions and farther, for instance, in the cities of Pasto, Cali, Bogotá, and Medellín. The periodicity of the activities and the time employed allowed the annual calculation to be fine-tuned. Eight hours of work were assumed for a working day based on local labor prices in 2016 (EUR 6.3).

In terms of the need for a comprehensive socioeconomic analysis, both self-consumption of production and trade were included as well as internal and external production costs. Therefore, the profit resulted from subtracting the internal and external costs from the total income, considering sales and the amount spent on self-consumption.

The determination of the total profit of the family farms had some limitations, especially in the family gardens, owing to the extensive list of products and the fact that several of them were not traded in the markets. Therefore, key informants were asked for specific calculations. For other products, exact yields during the year had never been estimated. However, a rough estimation was built in conjunction with the respondent. Regarding production costs, inputs, and capital related to perennial or permanent production were difficult to obtain when the item was purchased a long time ago, and interviewees could not recall dates and other relevant data. Once again, relatives and neighbors as key informants provided the missing information. In some cases, returning to the household to fulfill the questionnaire was compulsory.

3. Results

Of the three agroforestry systems identified in the *Inga* and *Camëntsá* indigenous communities, silvopastoral systems occupied most of the land-use area for livestock (SPL) and pasture production (SPP). Agrosilvopastoral was the second most important and was mainly focused on home gardens (HGs). In turn, agrisilvicultural represented the smallest area with several associated crops, such as beans supported by maize, lulo (*Solanum quitoense*), tamarillo intercropped with lulo, and maize. In addition to agroforestry, the protected areas of natural forests represented an essential part of the family farms (Table 2). According to *Camëntsá* key informants, the home garden was the place for cropping the traditional, ancestral food and other products, abundant in species and varieties [21]. It was also considered the most diverse place in the farm household [22] and included food species, medicinal species, trees, bushes, lianas, and small animals that supported the household needs [16]. This space provided income and beautified the landscape [23].

Table 2. The number of households holding the arrangements, total and average area, annual average expenses on family labor, annual average number of labor days spent, and percentage of family versus hired labor of the agroforestry systems in the Sibundoy Valley.

System	Arrangement	Number of Households Holding the System	Area (Ha)		Annual Average Expenses on Labor/Ha → EUR * (Average Number of Labor Days/Ha)				
			Total	Average	Family	Hired	Total	%	
								F	H
Agrosilvopastoral	Home garden (HG)	59	37.59	0.6	581.44 (92)	139 (22)	720.48 (114)	81	19
Silvopastoral	Livestock (SPL)	21	97.25	4.6	101.12 (16)	18.96 (3)	120.08 (19)	84	16
	Pasture (SPP)	19	21.75	1.1	18.96 (3)	31.6 (5)	50.56 (8)	37.5	62.5
Agrisilvicultural	Maize = Beans (AMB)	4	2.62	0.6	391.84 (62)	347.6 (55)	739.44 (117)	53	47
	Lulo (AL)	15	13.3	0.8	113.76 (18)	88.48 (14)	202.24 (32)	56	44
	Tamarillo/Lulo (ATL)	1	0.25	0.25	44.24 (7)	22.12 (3.5)	66.36 (10.5)	67	33
	Maize (AM)	1	1	1	164.32 (26)	113.76 (18)	278.08 (44)	59	41
Natural forest (NF)		7	32	4.6	12.64 (2)	0 (0)	12.64 (2)	100	0
TOTAL		67	205.76	13.55	1428.32	761.56	2189.88	67	33

Source: Own findings, * The opportunity cost of one Labor Day was around EUR 6.32 at the Sibundoy Valley in 2016.

Of the 67 households interviewed, 262 inhabitants were counted, with an average of 3.9 members in a family household, with a maximum of 10 and a few single-person households. Women were in the majority (51%) and, although children and the elderly were involved in agricultural activities, adult women and men were responsible for ensuring income, livelihoods, and food security.

3.1. Family and Hired Labor Requirements in Agroforestry Systems in Inga and Camëntsá

Home garden (HG), maize and bean (AMB), and maize (AM) agroforestry systems were, on average, the most labor-intensive per year (Table 2). The arrangements that used the most household labor included the HG, the silvopastoral system with livestock (SPL), and the tamarillo/lulo agrisilvicultural system (ATL) (Table 2). Although only 21 households were identified with the SPL arrangement, it occupied the largest area among the agroforestry systems and natural forests and was the one with the highest initial investment. It was organized under an extensive model; hence, the labor required per year was reduced (Table 2). The most labor-intensive activities in the SPL were manual milking (904.5 working days/year); followed by pasture maintenance (306.2 working days/year), cleaning of channels (260.5 working days/year), and rotation of herds so that they were temporarily concentrated in areas where there was a higher quantity and quality of forage (137 working days/year). In contrast, as strategic agroforestry systems in indigenous communities, home gardens were present in almost all family farms owing to their centrality to food security. Fifty-nine respondents had them; still, they occupied less than half the area of SPL, the latter generally occupying the largest area (Table 2).

Home gardens comprised biannual, annual, and perennial crops and small animal species, requiring multiple daily, weekly, monthly, semi-annual, and yearly activities that could generate employment for several household members, drawing on the human capital of each. For example, collecting eggs, feeding animals, and harvesting food for household consumption were activities that women and children carried out daily. Collecting fodder, cleaning the pigsty, and cooking for the animals required weekly work, in which women also played a decisive role, although other household members collaborated in these tasks. Planting, manuring, and fertilizing required monthly attention, mainly by men (Figure 2).

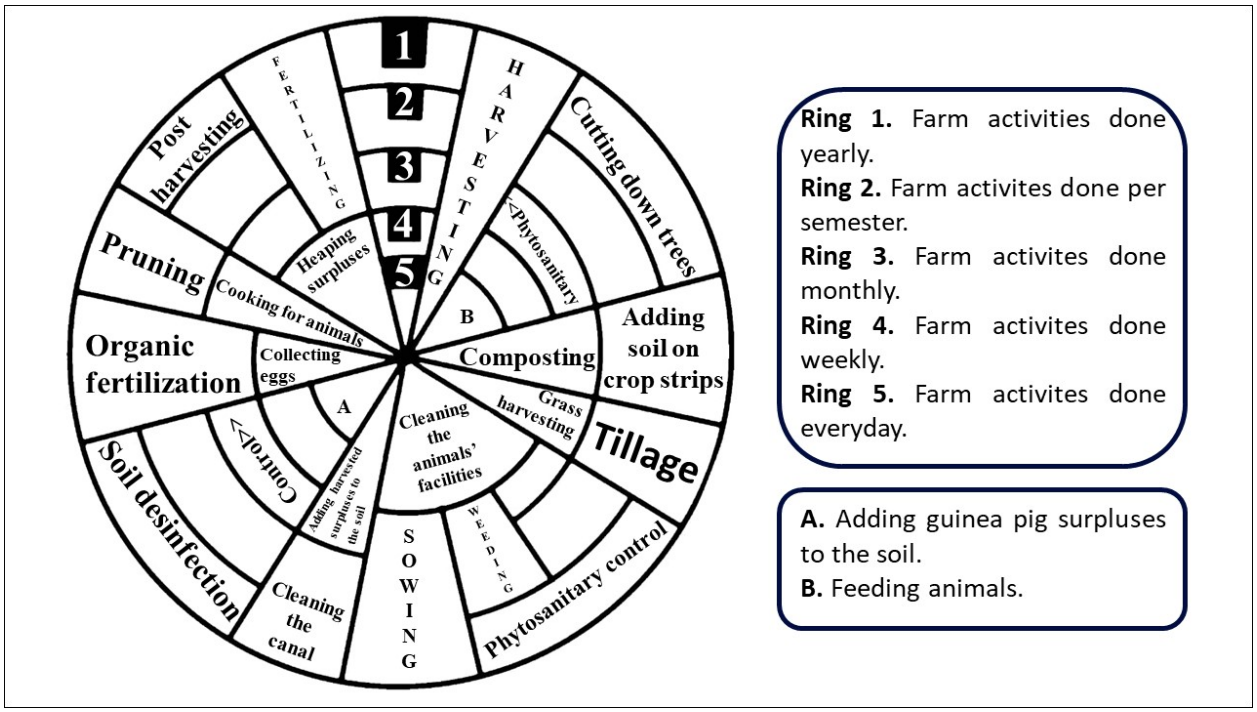

Figure 2. The most important labor activities and frequency of the management and maintenance of agrosilvopastoral systems.

Similarly, livestock production under perennial woody species required permanent management activities (Figure 3) such as milking, which was practiced at least once a day and contributed milk for the family and for sale to capture daily income, which was key to the nutritional and financial balance of households.

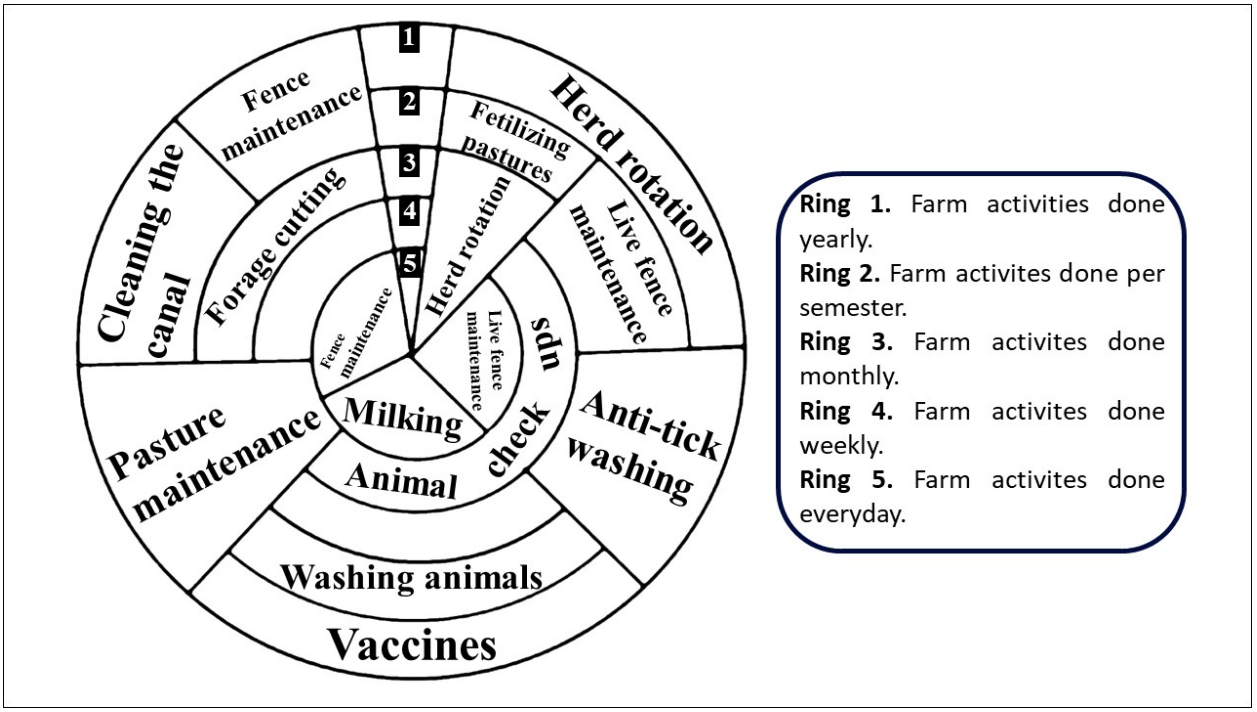

Figure 3. The most important labor activities and frequency of the management and maintenance of silvopastoral systems.

The agrisilvicultural system activities focused on annual, semi-annual, and monthly frequencies, as these were crops that required more spaced activities, such as harvesting fruits, which are primarily seasonal and annual (Figure 4).

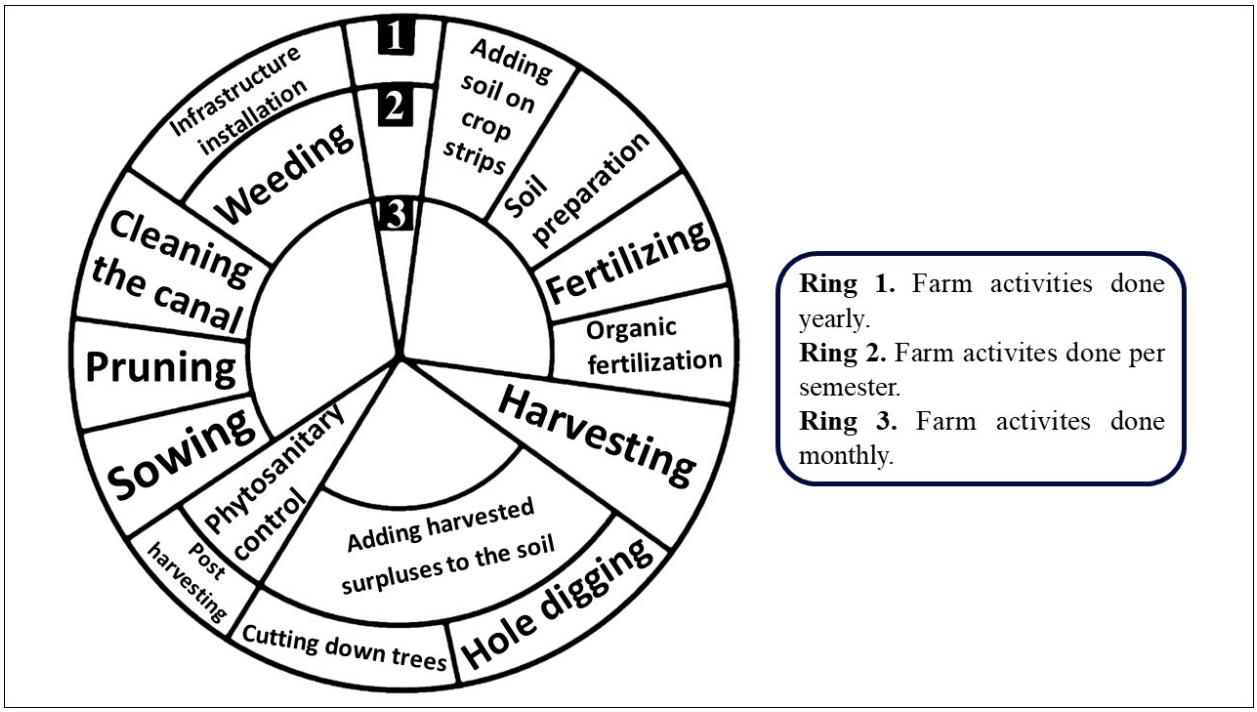

Figure 4. The most important labor activities and frequency of the management and maintenance of agrisilvicultural systems.

Regarding the work organization in the three agroforestry systems, all members of the *Camëntsá* and *Inga* households were involved, including the children who were in charge of harvesting the food for cooking at home every day. The adults were in charge of the tasks that required a more significant work effort; men and women split up and shared tasks equally (Figure 5).

3.2. Economic Participation of Family Labor in Income Generation

This study showed how family labor contributed to reducing the cost of production in agroforestry systems. Labor was identified as the most relevant production factor for maintaining these systems, with the average percentage required representing just over half (52%) of the total costs (Figure 6). Moreover, family labor (67%) was almost double the availability of hired labor (33%), so that its free contribution to average annual costs was around EUR 1428.3 (Table 2).

Although HGs required the second-highest amount of labor among agroforestry systems, given that their products are obtained throughout the year, they contributed to reducing more than 80% of labor costs, precisely EUR 581.4 on average per year (Figure 6). Because alternative sources of work were scarce for most of the members of these communities, only the opportunity cost associated with agricultural activities was considered. A similar situation arose in the SPL for milking activities. It is important to note that the goods obtained from natural forests depended exclusively on family labor. In contrast, the SPL employed more hired labor than domestic labor, as it was dedicated to activities that demanded special skills such as cleaning canals and felling trees. These activities required a greater physical effort, which was not always available in the family units. Therefore, these systems contributed to employment generation in the communities, thus reducing the need to leave the countryside to look for sources of employment.

Figure 5. Grandfather and daughter collecting a palm for traditional dish preparation.

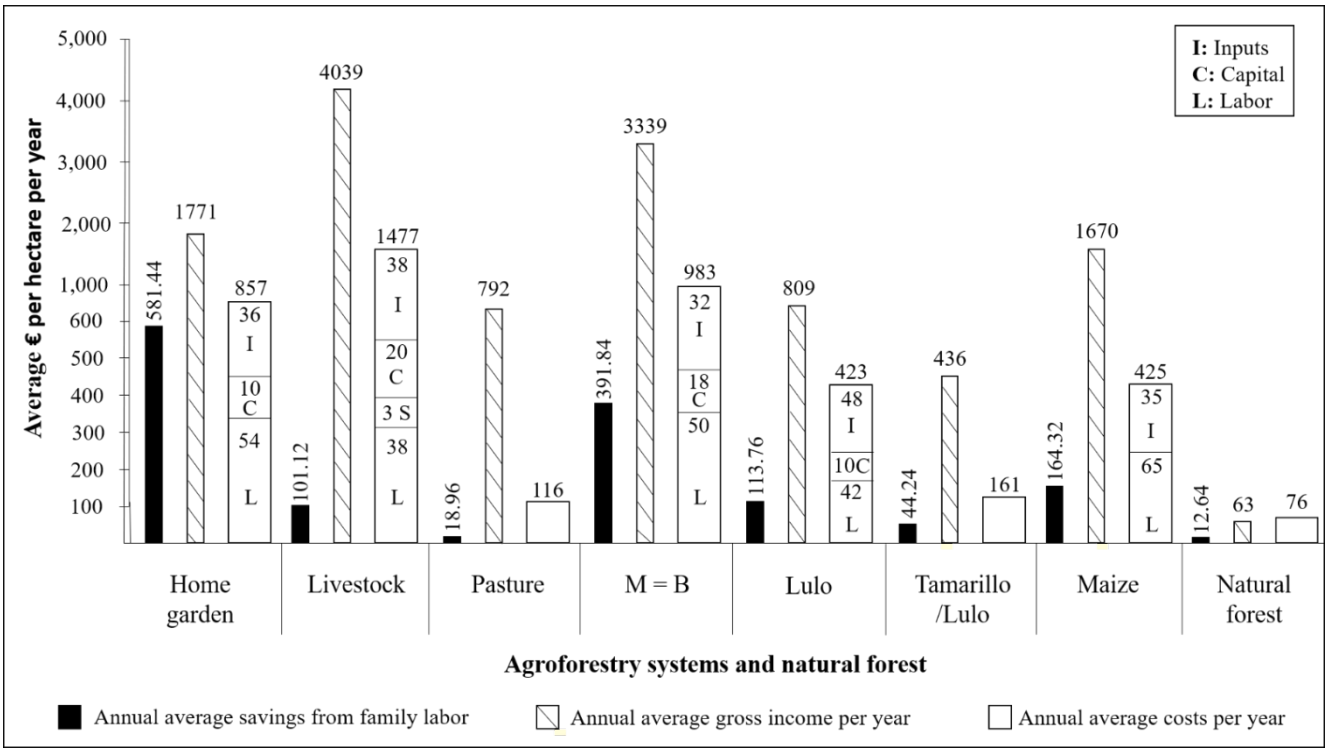

Figure 6. Annual average production costs avoided through family labor, gross income, and production costs of the agroforestry systems and natural forest.

In summary, family labor favored the reduction of production costs by between 7 and 68% of the total annual costs. Figure 6 shows how home gardens contributed to reducing total cost expenditure (68%) because of the employment of family labor. This employment had additional benefits as these activities, which were very close to the family, were mastered by the family members and critical to household food security. Other efficient systems for saving cash through household labor were cultivating AMB and AM, at 40 and 39%, respectively, as they required daily household work and were also central to household food security. In contrast, SPL, SPP, and NF systems were less effective in reducing costs, saving only 7, 16, and 17% of total costs, respectively, as these were less labor-intensive activities. In AL and ATL, the savings from family labor were also significant, amounting to 27% of total costs, as in both cases the fruits were harvested most of the year.

3.3. Most Active Groups of Farming Households in Terms of Income Generation, Labor Dependency, and Production of Goods

Three groups of households were identified from the cluster analysis. In the first group, households were represented by 45% of the similarities; 29 households comprised this group. This group of households (A) was distinguished by the largest farm sizes of the clusters. The second group of households (B) was also represented by more than 50% of the similarities and featured medium-sized holders (22 families). In the third group (C), the households were represented by more than 50% of the similarities; they featured smaller-sized farm holders (16 families).

Group C (smallest farms) had the best economic indicators of the three groups. Their performance was characterized by a favorable cost–benefit ratio (1.46) as well as a positive profitability level (113), explained by low production costs (EUR 3956.1) compared to the gross income generated (EUR 8716.7). These households had a higher average percentage (77%) of family labor use and the lowest average rate of non-agricultural labor (27%), which explained the reduced production costs. Additionally, this model had an impact on the protection of biodiversity as it was more abundant (73) within their systems (Table 3).

Although group A (largest farms) had the highest gross income (EUR 16,382.40) among the three groups, these households also recorded the highest production costs (EUR 7211.0) during the year and incurred the highest input costs (EUR 2520.9). These records reflected a reduction in profitability and cost–benefit ratio.

Group B (medium-sized farms) faced the worst scenario, as these households had the lowest estimated profitability rate and B/C ratio, mainly because they had the second-highest cost of production. Owing to their scale, the various resources available, especially labor, were not optimized, as these medium-sized farms used less labor per year, distinguishing them from the other two groups. On the contrary, this group showed a more significant percentage of hired labor, which, in the end, penalized their production costs and their overall efficiency level. The environmental aspects of these households reflected less intervention in biodiversity protection because of the reduced average number of protected species per hectare within the agroforestry systems. Subsequently, there was less diversity of species for self-consumption and marketing of the different products. As a result, they were more dependent on the market for their food sources, and they earned less income from the sale of their products.

The characteristics of each group were essential to understanding the relationship between the use of family labor and the achievement of livelihoods related to economic aspects and biodiversity. The variety of species harvested in *Inga* and *Camëntsá* communities were used for self-consumption and to obtain household goods and services. Therefore, family labor contributed to reduced production costs in agroforestry systems and ensured local food security and income generation, especially when options for off-farm labor were limited.

Table 3. Socioeconomic and environmental features of the cluster groups *.

Indicator		Biggest (A)	Medium (B)	Smallest (C)
Area (Ha)		**16.54**	9.88	6.12
Gross income (EUR)	Self-consumption	4152.15	2906.93	**4258.47**
	%	25	24	**49**
	Market	**12,230.25**	9447.28	4458.22
	%	75	**76**	51
	Total	**16,382.40**	12,354.21	8716.69
Costs (EUR)	Inputs	**2520.95**	1645.96	1454.58
	Capital	**1166.98**	532.39	448.71
	Services	**107.33**	54.76	56.84
	Labor	**3415.77**	1923.92	1995.91
	Total	**7211.03**	4157.05	3956.06
Family and hired labor (labor days per year)	Family	**402.43**	247.99	256.86
	%	67	69	**77**
	Hired	**137.43**	56.08	58.6
	%	**33**	31	23
	Total	**539.87**	304.08	315.46
B/C		0.71	0.62	**1.46**
Profitability		41.8	36.28	**113.14**
Average household members size		4	3.2	**4.7**
Number of species		51.34	29.04	73

Source: Own findings, * Values expressed in average.

4. Discussion

Agroforestry systems provide households with food, fuel, fodder and forage, fiber, timber, gums and resins, gardening material, thatching and hedging materials, raw material for handicrafts, and medicines [24]. Because of the product diversification, the sources of income have also become more diverse [25]; in addition, agroforestry has the capability to maintain soil fertility and restore degraded lands [26], optimize nutrient recycling, and allow the system to reduce or eliminate the use of some inputs [24], especially regarding water, energy, chemicals, labor, and provision of natural shelters while increasing the farm's profit [27]. The plant component adds litterfall to the system where, once decomposed, nutrients are transformed into organic matter in the soil, and hence, the crop component yield improves. In sum, crop and animal protection [28], nutrient availability, erosion control, biological control, availability of internal outputs for the production, and other benefits allow the farmers to reduce external input dependence, increase the system productivity, enhance recycling of organic material and generate better income [29,30].

Species and component diversity is a key feature of agroforestry systems that require family labor for maintenance and management. The more diverse the agroforestry system is, the more maintenance and harvesting activities it requires, which explains the many working days per year and the participation of most household members. For instance, a study conducted on the silvopastoral systems of the *Chol Mayan* indigenous community in Mexico revealed the permanent activities required for the systems' maintenance [31]. This study confirmed the importance of family labor in preserving biodiversity and contributing to the overall ecosystem stability in home gardens. Similar findings were found in Coq et al. (2017), who analyzed agroforestry systems in the Ecuadorian Amazon [32]. Although some agroforestry systems are considered indirectly related to preserving biodiversity, such as silvopastoral, they are directly related to the production of basic foodstuffs for the

daily diet and/or the sale of products that are key to the household income, coinciding with the findings in the Colombian Amazon [33]. Agroforestry focuses on ensuring and repairing food needs concerning availability, diversification, and sustainability. In contrast to monoculture, agroforestry provides an alternative, additional, and preferred food sources throughout the year [29]. Diversification is the path heading to livelihood security through economic condition improvement [34]. As revealed in this study, the home garden does not only provide food and medicinal plants but also fulfills an aesthetic function, as it beautifies the landscape. As observed in Juagibioy-Jamioy and Jacanamijoy-Juajibioy (2020), the surrounding natural forests supply different goods and services to *Inga* and *Camëntsá*, e.g., three types of canes found in the mountain upper forests to elaborate flutes, which are used in rituals and celebrations [35]. Similarly, studies on other Colombian regions revealed that the biodiversity related to the natural and transformed ecosystems is of utmost importance for the indigenous communities, contributing to the discussion concerning the links between agrobiodiversity and an alternative ordering of human–environment relations, other than export-oriented production [36].

The household work organization involves all family members in performing the different activities. In other words, the family is a team effort to optimize the household's family labor force. Gender issues are largely relativized, as the *Inga* and *Camëntsá* male and female activities are organized according to a logic of complementarity. This dynamic is often observed in communities far from urban centers that therefore have no employment options outside primary activities. In contrast, in areas that are close to industrial and urban areas, particularly the maquila industry, men and women (mainly the younger ones) can access outside work independent from each other, as has also been documented in agroforestry systems in China [37].

Hired labor represents 33% of the total labor in *Inga* and *Camëntsá* communities, which denotes the need for extra labor for specialized activities. External labor is mainly relevant in the silvopastoral system and, more specifically, in pasture harvesting (62.5% of the total). It is also essential in the agrisilvicultural system, mainly in the cultivation of maize and beans, lulo, and maize. The hiring of labor primarily replaces specialized tasks, as has also been found in other communities in Mexico open to outside labor [6]. Although some smallholders hire workers, their contribution is limited and seasonal. In addition, they use more family labor than capital to produce food, medicine, fuel, and fiber [38], which is partly due to ecosystem biodiversity and the lack of employment opportunities outside the family unit, especially if they are not located close to urban and/or industrial centers. As a result, the marginal productivity of on-farm activities increases in these communities, and time spent on off-farm activities decreases [39].

Given the low volumes of each product and their heterogeneous quality, the commercialization of agroforestry products can be difficult owing to reduced market access and limitations in transport and the agro-industrial processing capacity in the Sibundoy Valley. This situation has been exacerbated by a lack of producer organization and governmental support, as documented in a similar study in Bolivia [40]. As a result, it is increasingly common for some of the men and women in the families to work outside the farm to supplement the family income, as reported in a study conducted in Mexico [31], and to hire workers to supplement their labor.

From an economic point of view, several studies have indicated that agroforestry can generate almost twice the cost–benefit ratio (B/C) of traditional agriculture [41]. From the farmer's perspective, there is also evidence that agroforestry can be more profitable and less risky than other agricultural options, as it provides several products at different times of the year [42,43]. If one product is not harvested, there is an alternative one [44]. As agroforestry entails more than one component, it offers more goods and environmental services than mono-production systems [45].

Family labor favors the reduction of production costs during the year and is of utmost importance for sustaining agroforestry systems and the livelihoods of the *Inga* and *Camëntsá* communities, as well as the preservation of biodiversity and family food security. Along the

same lines, other studies in relatively isolated regions of Zimbabwe [46] and Ecuador [32] have concurred, with the caveat that when communities are influenced by acute effects of climate change, as in the first case, the risks to the productivity of agroforestry systems increase. Proximity to urban areas and the possibility of developing off-farm activities can also make agroforestry systems more straightforward and more dependent on wage labor than on family labor, as the latter finds employment in urban and/or industrial centers. This has also been documented in the case of the Chinese province of Henan [37]. The results from the inquiry conducted in China reiterated the centrality of family labor in maintaining livelihoods, generating household income, wisely using and conserving biodiversity, and maintaining community traditions [36].

Despite this evidence, in Colombia, policies have been directed toward the investment of the private sector [47], the use of natural resources, infrastructure investment, and the development of agricultural systems [48] under monoproductive approaches supported by the state economic development policies [49]. These policies neglect the protection of natural ecosystems, undermining biodiversity [50,51], for instance, the glyphosate spraying allowance for coca leaf crop control [52] or national macroeconomic policies that harmonize with transnational economic dynamics in the sugar cane sector. Development projects often focus on natural resource exploitation, which underpins the domestic economy while excluding the social and environmental externalities [48]. In this regard, studies focusing on the socioeconomic and environmental benefits of agroforestry practices are needed to promote its adoption and spread.

5. Conclusions

The *Inga* and *Camëntsá* communities have modeled agroforestry systems with a high degree of biodiversity. However, we identified signs of reordering from the effects of urbanization associated with the fragile organization of producers and virtually no governmental support. The main component of these agroforestry systems in the *Inga* and *Camëntsá* communities lies in family labor. Family labor is an essential part of the production costs in these systems. It is key to the use and conservation of biodiversity and, consequently, most families' food security and livelihoods.

The three types of agroforestry systems showed varied productive orientations, with family gardens as a common element. Silvopastoral systems favored extensive regimes, thus occupying the most significant area relative to other systems but the least amount of labor employment per year. On the other hand, the agrosilvopastoral systems demanded permanent ecosystem maintenance activities, thus generating the most considerable labor among the systems, allowing households to diversify their production and obtain different food sources throughout the year, and, therefore, lower risk of food insecurity. Hence, the more family labor used in the production unit, the more biodiverse it is, with greater capacity for food self-consumption, fewer direct production costs, and a higher rate of profitability. However, the challenge is that more employment is required for the adequate maintenance of the farms in this way. In addition, it highlights that cultural values are related to the preferred use of family labor for the management of agroforestry systems, mainly at the level of the family garden.

These dynamics also revealed that the traditional knowledge and skills of the *Inga* and *Camëntsá* communities contributed to a significant level of resilience to the effects of socioeconomic risks. However, trends toward a certain specialization, as verified in medium-scale family farms, revealed that this balance is fragile and threatens the sustainability of livelihoods, income, and ecosystems.

Biodiversity protection and management are recommended in the *Camëntsá* and *Inga* indigenous territory, through both the adoption of agroforestry systems mainly in the flat areas and the protection of natural forest at the upper surrounding areas of the Sibundly Valley. The implementation of policies that promote biodiversity conservation and use through agroforestry systems is required to achieve this goal. This research provided an analysis of the importance of family labor in these communities and demonstrated the

sustainable nature of family strategies. However, this research should be continued by studies that evaluate non-agricultural work, which in some instances complements family income and explains why there is a greater investment in hired labor, as estimated in the medium-scale group.

These findings contribute to academic research as the basis for discussing and outlining public policy options for indigenous communities to promote their integral development under sustainable, traditional models. Similarly, the relevance of the "local" knowledge that arises from the practices of indigenous agroforestry is valued, which may be relevant to addressing multiple and convergent global crises. Since grounded knowledge of agroforestry systems is not limited to specific localities, a full understanding of indigenous labor used in agroforestry systems in the context of global transformations can contribute, among others, to the mitigation of climate change and sustainable food production while increasing the agroforestry system's resilience capacity.

Author Contributions: Conceptualization, V.J.P.B., W.B. and R.W.C.M.; methodology, V.J.P.B.; validation, A.Á.M.; formal analysis, V.J.P.B., C.C., R.W.C.M. and A.Á.M.; investigation, V.J.P.B.; writing—original draft preparation, V.J.P.B.; writing—review and editing, R.W.C.M., A.Á.M. and C.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Erasmus Mundus EMA-2 EULALinks.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Special thanks to *Bata* Omayra Juagibioy and her family.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. González, N.C.; Kröger, M. The potential of Amazon indigenous agroforestry practices and ontologies for rethinking global forest governance. *For. Policy Econ.* **2020**, *118*, 102257. [CrossRef]
2. Wang, W.; Gong, J.; Wang, Y.; Shen, Y. Exploring the effects of rural site conditions and household livelihood capitals on agricultural land transfers in China. *Land Use Policy* **2021**, *108*, 105523. [CrossRef]
3. Wang, Y.; Zhang, Q.; Li, Q.; Wang, J.; Sannigrahi, S.; Bilsborrow, R.; Bellingrath-Kimura, S.D.; Li, J.; Song, C. Role of social networks in building household livelihood resilience under payments for ecosystem services programs in a poor rural community in China. *J. Rural. Stud.* **2021**, *86*, 208–225. [CrossRef]
4. Yang, B.; Feldman, M.W.; Li, S. The status of perceived community resilience in transitional rural society: An empirical study from central China. *J. Rural. Stud.* **2020**, *80*, 427–438. [CrossRef]
5. Ford, J.D.; King, N.; Galappaththi, E.K.; Pearce, T.; McDowell, G.; Harper, S.L. The Resilience of Indigenous Peoples to Environmental Change. *One Earth* **2020**, *2*, 532–543. [CrossRef]
6. Ribeiro Palacios, M.; Huber-Sannwald, E.; García Barrios, L.; Peña de Paz, F.; Carrera Hernández, J.; de Guadelupe Galindo Mendoza, M. Landscape diversity in a rural territory: Emerging land use mosaics coupled to livelihood diversification. *Land Use Policy* **2013**, *30*, 814–824. [CrossRef]
7. Lawrence, T.J.; Stedman, R.C.; Morreale, S.J.; Taylor, S.R. Rethinking Landscape Conservation: Linking Globalized Agriculture to Changes to Indigenous Community-Managed Landscapes. *Trop. Conserv. Sci.* **2019**, *12*. [CrossRef]
8. Escallón, J.M.V. The historical relationship between agrarian reforms and internal armed conflicts: Relevant factors for the Colombian post-conflict scenario. *Land Use Policy* **2021**, *101*, 105138. [CrossRef]
9. Shabtay, A. Adaptive traits of indigenous cattle breeds: The Mediterranean Baladi as a case study. *Meat Sci.* **2015**, *109*, 27–39. [CrossRef]
10. Xu, D.; Deng, X.; Guo, S.; Liu, S. Labor migration and farmland abandonment in rural China: Empirical results and policy implications. *J. Environ. Manag.* **2019**, *232*, 738–750. [CrossRef]
11. Muñoz-Rios, L.A.; Vargas-Villegas, J.; Suarez, A. Local perceptions about rural abandonment drivers in the Colombian coffee region: Insights from the city of Manizales. *Land Use Policy* **2020**, *91*, 104361. [CrossRef]
12. Špulerová, J.; Drábová, M.; Lieskovský, J. Traditional agricultural landscape and their management in less favoured areas in Slovakia. *Ekológia Bratislava* **2016**, *35*, 1. [CrossRef]
13. Jha, S.; Kaechele, H.; Sieber, S. Factors influencing the adoption of agroforestry by smallholder farmer households in Tanzania: Case studies from Morogoro and Dodoma. *Land Use Policy* **2021**, *103*, 105308. [CrossRef]

14. Maia, A.G.; Burney, J.A.; Martínez, J.D.M.; Cesano, D. Improving production and quality of life for smallholder farmers through a climate resilience program: An experience in the Brazilian Sertão. *PLoS ONE* **2021**, *16*, e0251531. [CrossRef]
15. Bucheli, V.J.P.; Fuentes, J.C.B. Caracterización técnica y económica de los agrosistemas de producción en dos resguardos indígenas del Putumayo (Colombia. *Acta Agronómica* **2014**, *63*, 91–100. [CrossRef]
16. Bucheli, V.J.P.; Bokelmann, W. Agroforestry systems for biodiversity and ecosystem services: The case of the sibundoy valley in the colombian province of putumayo. *Int. J. Biodivers. Sci. Ecosyst. Serv. Manag.* **2017**, *13*, 380–397. [CrossRef]
17. Patil, S.J.; Maheswarappa, V. Agroforestry systems classification. In *Agroforestry Theory and Practices*; Raj, A.J., Ed.; Scientific Publishers: Jodhpur, India, 2014; pp. 54–66.
18. Zoellner, J.; Harris, J.E. Mixed-Methods Research in Nutrition and Dietetics. *J. Acad. Nutr. Diet.* **2017**, *117*, 683–697. [CrossRef]
19. Řezanková, H. Cluster Analysis of Economic Data. *Stat. Stat. Econ. J.* **2014**, *94*, 73–86.
20. Legendre, P.; Legendre, L. *Numerical Ecology*, 3rd ed.; Elsevier: Amsterdam, The Netherlands, 2012; Volume 24.
21. Juagibioy, I. Interview with Vandreé Palacios. In *Personal Interview*; Putumayo: Sibundoy, Colombia, 2015; pp. 1–5.
22. Jacanamijoy, B. Interview with Vandreé Palacios-1. In *Personal Interview*; Putumayo: Sibundoy, Colombia, 2016; pp. 1–6.
23. Juagibioy, O. Interview with Vandreé Palacios-2. In *Personal Interview*; Putumayo: Sibundoy, Colombia, 2016; pp. 1–10.
24. Smith, J. *Agroforestry: Reconciling Production with Protection of the Environment*; The Organic Research Centre: Berkshire, MA, USA, 2010.
25. Asaah, E.K.; Tchoundjeu, Z.; Van Damme, P. Beyond vegetative propagation of indigenous fruit trees: Case of Dacryodes edulis (G. Don) H. J. Lam and Allanblackia floribunda Oliv. *Afr. Focus* **2012**, *25*, 61–72. [CrossRef]
26. Leakey, R.R.B. The role of trees in agroecology and sustainable agriculture in the tropics. *Annu. Rev. Phytopathol.* **2014**, *52*, 113–133. [CrossRef] [PubMed]
27. Gao, J.; Barbieri, C.; Valdivia, C. A socio-demographic examination of the perceived benefits of agroforestry. *Agrofor. Syst.* **2014**, *88*, 301–309. [CrossRef]
28. Benayas, J.M.R.; Bullock, J.M.; Newton, A.C. Creating woodland islets to reconcile ecological restoration, conservation, and agricultural land use. *Front. Ecol. Environ.* **2008**, *6*, 329–336. [CrossRef]
29. Magcale-Macandog, D.B.; Rañola, F.M.; Rañola, R.F.; Ani, P.A.B.; Vidal, N.B. Enhancing the food security of upland farming households through agroforestry in Claveria, Misamis Oriental, Philippines. *Agrofor. Syst.* **2009**, *79*, 327–342. [CrossRef]
30. Chamberlain, J.; Mitchell, D.; Brigham, T.; Hobby, T.; Zabek, L.; Davis, J. Forest farming practices. In *North American Agroforestry: An Integrated Science and Practice*; American Society of Agronomy: Madison, WI, USA, 2015. [CrossRef]
31. Pignataro, A.G.; Levy-Tacher, S.; Aguirre-Rivera, J.R.; Toral, J.N.; Espinosa, M.G.; Carmona, N.R. Silvopastoral systems of the Chol Mayan ethnic group in southern Mexico: Strategies with a traditional basis. *J. Environ. Manag.* **2016**, *181*, 363–373. [CrossRef] [PubMed]
32. Coq-Huelva, D.; Higuchi, A.; Alfalla-Luque, R.; Burgos-Morán, R.; Arias-Gutiérrez, R. Co-evolution and bio-social construction: The kichwa agroforestry systems (Chakras) in the ecuadorian amazonia. *Sustainability* **2017**, *9*, 1920. [CrossRef]
33. Fonseca-Cepeda, V.; Idrobo, C.J.; Restrepo, S. The changing chagras: Traditional ecological knowledge transformations in the Colombian amazon. *Ecol. Soc.* **2019**, *24*. [CrossRef]
34. Kassie, G.W. Agroforestry and farm income diversification: Synergy or trade-off? The case of Ethiopia. *Environ. Syst. Res.* **2018**, *6*, 8. [CrossRef]
35. Juagibioy-Jamioy, A.; Jacanamijoy-Juajibioy, J. Bacó Alfonso: Una historia sobre los rituales de flautas del 717 pueblo kamëntsá. In *Mundos de Creación de los Pueblos Indígenas de América Latina*, 1st ed.; Quiñones-718; Aguilar, A., Ed.; EnredARS: Bogota, Colombia, 2020; Volume 10, pp. 201–222.
36. Baumann, M.D. Agrobiodiversity's caring material practices as a symbolic frame for environmental governance in Colombia's southern Tolima. *Geoforum* **2021**. [CrossRef]
37. Zhang, L.; Liao, C.; Zhang, H.; Hua, X. Multilevel modeling of rural livelihood strategies from peasant to village level in Henan Province, China. *Sustainability* **2018**, *10*, 2967. [CrossRef]
38. Rapsomanikis, G. *The Economic Lives of Smallholder Farms. An Analysis of Household Data from Nine Countries*; FAO: Rome, Italy, 2015.
39. Almeida, A.N.; Bravo-Ureta, B.E. Agricultural productivity, shadow wages and off-farm labor decisions in Nicaragua. *Econ. Syst.* **2019**, *43*, 99–110. [CrossRef]
40. Jacobi, J.; Rist, S.; Altieri, M.A. Incentives and disincentives for diversified agroforestry systems from different actors' perspectives in Bolivia. *Int. J. Agric. Sustain.* **2017**, *15*, 365–379. [CrossRef]
41. Venkatesh, A.; Mohapatra, K.P.; Arumachalam, A.; Rajkhowa, D.J.; Bharali, S.; Ngachan, S.V. Agroforestry and food security. In *Agroforestry Theory and Practices*; Raj, A.J., Lal, S.B., Eds.; Scientific Publishers: Jodhpur, India, 2014; pp. 34–53.
42. Baul, T.K.; Chakraborty, A.; Nandi, R.; Nath, T.K.; Mohiuddin, M. Phytosociological attributes and ecosystem services of homegardens of Maheshkhali island of Bangladesh. *Trees, For. People* **2021**, *5*, 100092. [CrossRef]
43. Kunhamu, T.K. Tropical homegardens. In *Agroforestry Theory and Practices*; Raj, A.J., Lal, S.B., Eds.; Scientific Publishers: Jodhpur, India, 2014; pp. 365–375.
44. Rancane, S.; Makovskis, K.; Lazdina, D.; Daugaviete, M.; Gutmane, I.; Berzins, P. Analysis of economical, social and environmental aspects of agroforestry systems of trees and perennial herbaceous plants. *Agron. Res.* **2014**, *12*, 589–602.

45. Duffy, C.; Toth, G.G.; Hagan, R.P.O.; McKeown, P.C.; Rahman, S.A.; Widyaningsih, Y.; Sunderland, T.C.H.; Spillane, C. Agroforestry contributions to smallholder farmer food security in Indonesia. *Agrofor. Syst.* **2021**, 1–16. [CrossRef]
46. Dobbie, S.; Schreckenberg, K.; Dyke, J.G.; Schaafsma, M.; Balbi, S. Agent-based modelling to assess community food security and sustainable livelihoods. *J. Artif. Soc. Soc. Simul.* **2018**, *21*, 1–23. [CrossRef]
47. Correa-García, E.; Vélez-Correa, J.; Zapata-Caldas, E.; Vélez-Torres, I.; Figueroa-Casas, A. Territorial transformations produced by the sugarcane agroindustry in the ethnic communities of López Adentro and El Tiple, Colombia. *Land Use Policy* **2018**, *76*, 847–860. [CrossRef]
48. Fontanilla-Díaz, C.A.; Preckel, P.V.; Lowenberg-DeBoer, J.; Sanders, J.; Peña-Lévano, L.M. Identifying profitable activities on the frontier: The Altillanura of Colombia. *Agric. Syst.* **2021**, *192*, 103199. [CrossRef]
49. Rodríguez-De-Francisco, J.C.; del Cairo, C.; Ortiz-Gallego, D.; Velez-Triana, J.S.; Vergara-Gutiérrez, T.; Hein, J. Post-conflict transition and REDD+ in Colombia: Challenges to reducing deforestation in the Amazon. *For. Policy Econ.* **2021**, *127*, 102450. [CrossRef]
50. Rivera-Pedroza, L.F.; Escobar, F.; Philpott, S.M.; Armbrecht, I. The role of natural vegetation strips in sugarcane monocultures: Ant and bird functional diversity responses. *Agric. Ecosyst. Environ.* **2019**, *284*, 106603. [CrossRef]
51. Brüning, L.Z.; Krieger, M.; Meneses-Pelayo, E.; Eisenhauer, N.; Pinilla, M.P.R.; Reu, B.; Ernst, R. Land-use heterogeneity by small-scale agriculture promotes amphibian diversity in montane agroforestry systems of northeast Colombia. *Agric. Ecosyst. Environ.* **2018**, *264*, 15–23. [CrossRef]
52. Idrovo, A.J.; A Rodríguez-Villamizar, L. Moving back in policy banning glyphosate use in Colombia. *Lancet* **2018**, *392*, 1194. [CrossRef]