



Perception of ecosystem services by family farmers in the municipality of Irituia/PA, Eastern Amazon: subsidies for forest restoration

Percepção de serviços ecossistêmicos por agricultores familiares no município de Irituia/PA, Amazônia oriental: subsídios para a restauração florestal

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ABSTRACT: Due to the lack of studies about the sociocultural dimension of ecosystem services, we analyze in this work the perception of these benefits by family farmers who have agroforestry systems in the northeast of Pará, in the Amazon region. With this objective, we categorize forest restoration strategies based on primary data collection - interviews, semi structured questionnaire, illustrated questionnaire and Likert Scale. Through the relative perception based on the application of Likert scales, we observed that the farmers recognize the benefits provided by agroforest systems and natural landscapes, with high perception of ecosystem services in all the categories present in the Millennium ecosystem evaluation. Furthermore, the higher perceptions of ecosystem services are related to the group of farmers with a smaller area of forest reserve and bigger area of agroforest systems. The result suggests that loss of forest area, at the individual level, probably drives to a higher sense of the benefits of natural systems and thus, the increment in agroforestry systems constitutes an attempt to return to functions and benefits lost through environmental degradation over time. In general, support programs are necessary to strengthen the capacity of agroforestry systems to provide ecosystem services and increase biodiversity conservation.

Keywords: ecosystem services; agroforest systems; forest recovery; family farmers; Amazon.

RESUMO:

Devido à carência de estudos sobre a dimensão sociocultural de Serviços Ecossistêmicos (SE), analisamos a percepção desses benefícios por agricultores familiares que têm sistemas agroflorestais (SAF) no Nordeste Paraense, visando subsidiar ações que aumentem a abrangência e eficiência da restauração florestal. A partir da percepção relativa baseada em escala *Likert*, observou-se que os agricultores reconhecem os benefícios advindos das paisagens naturais e dos sistemas agroflorestais, apresentando em geral alta percepção de Serviços Ecossistêmicos em todas as categorias propostas pela Avaliação Ecossistêmica do Milênio (provisão, regulação, suporte e cultural), com destaque aos serviços culturais referentes a *tranquilidade/espiritualidade* (*X* 4,98) e paz de espírito proporcionada por ambientes mais naturais e arborizados, e aos serviços de provisão relacionados a *ter qualidade e boa quantidade de água* (*X* 4,93), além do entendimento de que contribuem para a restauração de áreas degradadas. Neste estudo, as percepções mais altas de SE foram relacionadas ao grupo de agricultores com menor área de reserva florestal e maior área de SAF. Este resultado sugere que a perda de área florestal, no âmbito individual, possivelmente leva a uma maior sensibilização quanto aos benefícios dos sistemas naturais. O incremento das áreas de SAF constituem uma tentativa de retorno às funções e benefícios perdidos pela degradação ambiental ao longo do tempo. De forma geral, programas de apoio são necessários para fortalecer a capacidade dos SAFs em prover Serviços Ecossistêmicos e aumentar a conservação da biodiversidade.

Palavras-chave: percepção; serviços ecossistêmicos; agricultores familiares; sistemas agroflorestais; Amazônia.

1. Introduction

Forest restoration initiatives, at global and regional level, have emerged strongly with the aim of recovering ecosystem functions and benefits and addressing global climate crises and biodiversity loss (Chazdon, 2008). Brazil has joined international agreements (e.g. Bonn Challenge, 20x20 Initiative), set a target of restoring around 12 million hectares of forest by 2030 and implemented national restoration laws (MAPA, 2016). Brazil's commitment to recovery is largely in the Amazon, especially in states with the highest rates of deforestation, such as Pará.

Alternatives such as natural regeneration and Agroforestry Systems (SAFs), consisting of a consortium of agricultural crops with native and/or exotic tree species (Amador, 2003), imply a better cost-benefit ratio for forest restoration, since the total planting of trees imposes a high financial cost. These systems can constitute a transition phase, following an "agrosuccessional model" towards

a more biodiverse forest, close to the condition of native forest (Vieira *et al.*, 2009).

In addition, family farmers have traditionally cultivated SAFs, particularly in the Amazon, through accumulated knowledge passed down through generations of family members (Henkel & Amaral, 2008). For these reasons, SAFs are being identified as the most widely used model of landscape forest restoration in the Amazon (Almeida *et al.*, 2006). A recent study identified the ascendancy of forest recovery actions in the Northeast of Pará practiced by family farmers (Carneiro *et al.*, 2017).

SAFs are considered to promote benefits for biodiversity and Ecosystem Services (ES), in particular the mitigation of the effects of climate change (Padovan *et al.*, 2017) compared to other productive systems, although less than conserved natural forests (Brancalion *et al.*, 2015; Santos *et al.*, 2019). Despite all the benefits promoted by agroforestry systems, there is a lack of incentives to motivate farmers to maintain environmentally friendly modes of production (Ajayi, 2007). Understanding farmers'

motivation is one of the key factors for successful restoration (Diederichsen *et al.*, 2017), as they are the agents who implement forest recovery and the adoption of more sustainable farming systems.

The perception of ES can influence the motivation of these actors to participate in initiatives to restore degraded areas. In a study carried out in Australia, for example, it was shown that biodiversity and ES would comprise the greatest motivations for restoring environments by participants with different restoration roles, community groups, government agencies, private organizations and landowners (Hagger *et al.*, 2017). However, studies addressing the social issues of restoration are scarce, especially under the spectrum of perception (Aronson *et al.*, 2010; Wortley *et al.*, 2013), in Brazil and the Amazon in particular.

Ecosystem services (ES) correspond to the benefits that people obtain from ecosystems (Millennium Ecosystem Assessment, 2005). Environmental Services (ES) consist of the benefits generated by human actions in ecosystems through the management of these resources (Constanza *et al.*, 1997), such as replanting riparian vegetation, fencing off springs, erosion control practices to prevent soil leaching and silting up of watercourses (Tôsto *et al.*, 2011). In this paper, we use the terminology Ecosystem Services (ES) because we understand that farmers co-produce Ecosystem Services, since they do not intentionally develop management and handling practices aimed at the services provided.

Studies have long focused on the ES provided by natural ecosystems and the loss of these services as a result of human actions (Constanza, 1997). There is a growing number of studies on the values - material and non-material - that people attribute to nature and ecosystems (Torres *et al.*, 2016). How-

ever, few studies have focused on the socio-cultural dimension of ES, and there is a need to advance in the understanding of these benefits for human beings (Martín-López *et al.*, 2012).

As SAFs are related to various environmental benefits, such as biodiversity, water and carbon (Abdo *et al.*, 2008), it is plausible to assume that the attitude towards implementing SAFs was determined by a greater perception on the part of the ES. Similarly, it is expected that the maintenance of larger areas of forest remnants is related to a greater perception of ES. However, this relationship is still little explored by science and will therefore be the subject of this study. It is believed that understanding this issue is relevant to verifying whether, in fact, the adoption of SAFs by family farmers results in a greater supply of ES and, consequently, provides a greater capacity to contribute to the forest restoration of landscapes.

The way we observe, understand, interpret and evaluate objects, actions and policies is based on the sensory and experiential experiences of the individual (Bennet, 2016). Since the environment is constantly changing, perception can take on different forms that are constructed from so-called points of view, or the cultural repertoire of individuals and social groups (Ferrara, 1993). In addition, the individual's emotional ties to the space in which they live shape their perception of the SE provided by natural environments and influence their choice of agricultural practices and environmental conservation. Therefore, a person's perception can be influenced by the political and cultural context in their environment and this perception can affect the ways in which (agro)ecosystems are used and managed, given that an individual's contact with

forests acts as a predictor of the value attributed to them (Torres *et al.*, 2016).

Ingold (2000) points out that in addition to being a cultural issue, the perception of something is also biological and they are inextricably linked. Therefore, perception is not an individual issue. If, on the one hand, genetics introduces changes that affect the way we express ourselves to others, which in turn is modified by the environment, on the other, human beings are guided in developing a perceptive awareness of their surroundings and the possibilities for action that exist. The perception of the SE would be an ecological approach to situating family farmers through the experience of their SAF. This knowledge would be passed down through continuous generations in the context of engagement with the land.

Taking into account the need to engage and encourage family farmers to carry out forest recovery, this study analyzes the degree of importance and perception of Ecosystem Services by family farmers who practice Agroforestry Systems, in order to support actions that increase the scope and efficiency of forest restoration. To this end, we assessed which Ecosystem Services are most valued, farmers' perceptions of the Ecosystem Services offered by forested areas and their main motivations for forest recovery.

2. Materials and methods

2.1. The municipality of Irituia in Pará and agroforestry systems

The municipality of Irituia (Figure 1), located in the northeast of the state of Pará, was selected for two reasons:

1) The municipality stands out for its adoption of agro-ecological practices for productive activities, specifically Agroforestry Systems (SAF), which according to Oliveira (2006), have been used in Irituia for hundreds of years by actors who use the territory differently, in the form of backyards;

2) SAFs are widespread in Irituia, ensuring long-lasting SAFs and providing genuine insights from those who have lived in the environment for a long time.

The municipality also stands out for being predominantly rural, with around 79.20% of its population living in the countryside (IBGE, 2010). The municipality's economy is based on agriculture, extraction and wood processing, and is mainly made up of family farmers who practice subsistence farming (Silva *et al.*, 2015).

Labeled by Oliveira (2006) as "innovative farmers", the difficulty in accessing public policies has led them to innovate by experimenting with new arrangements of species, expanding their forest backyards to other parts of their agro-ecosystems. Agroforestry systems are known nominally by Irituia's farmers as "sítio" and "plantio casado" and their products are being increasingly valued by local cooperatives. The agroforestry system (SAF) is a model of agricultural cultivation that uses different tree species (Amador, 2003). This model is widely used in the Amazon because it provides an alternative to the itinerant agriculture practiced in the region and reduces pressure on forests (Dubois *et al.*, 1996). These systems have great potential for providing ecosystem services and are traditionally used by family farmers. Furthermore, they are

cost-effective because they can generate income from the first years of planting (Vieira *et al.*, 2009).

In the early 2000s, projects such as the Socio-Environmental Development Program for Rural Family Production (PROAMBIENTE) sought to promote a balance between the conservation of natural resources, rural family production and remuneration for environmental services and to engage farmers in the implementation of SAF as an agroecological transition towards sustainable agriculture (Mattos, 2011). In Irituia, the adoption of agroecological practices really intensified in 2009,

through the Municipal Department of Agriculture (SEMAGRI) (Oliveira *et al.*, 2015).

2.2 Data collection and analysis

In the search for farmers engaged in agroforestry systems, the sample of farmers was initially selected through contact with the Department of Agriculture of the Municipality of Irituia and the Irituia Farmers' Cooperative. In view of the aim of this research to analyze the perception of Ecosystem Services (ES) by family farmers, the sample was

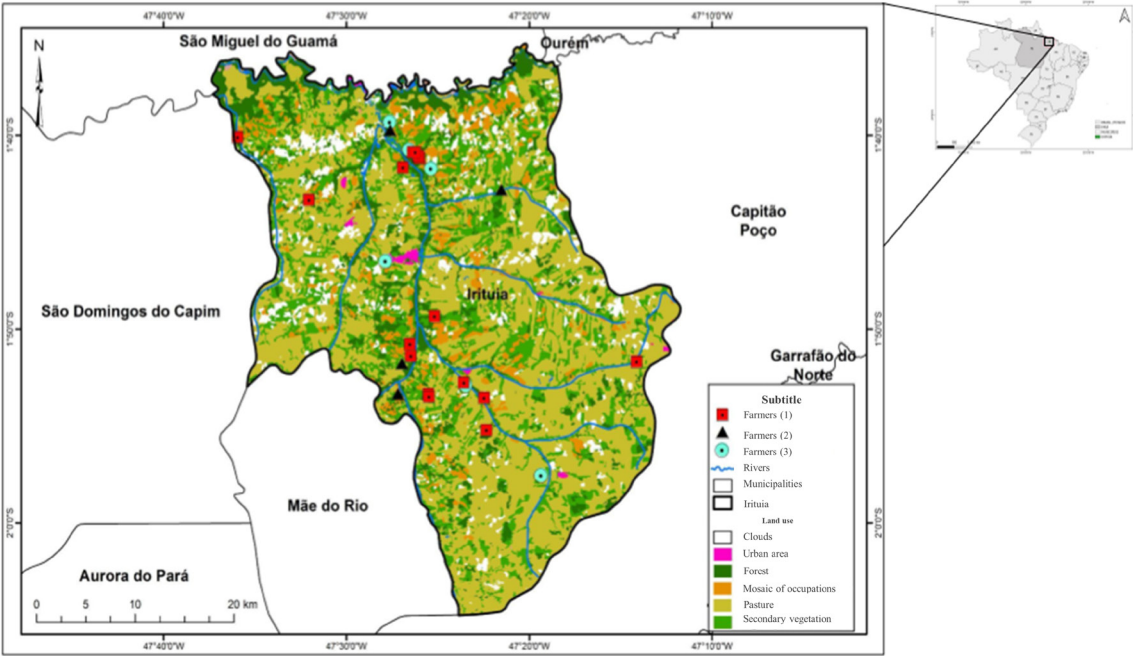


FIGURE 1 - Land use in the municipality of Irituia and location of farmers according to typology. Proposal extracted from TerraClass (2014) with the groups Farmer type 1) little SAF and little forest reserve; Farmer type 2) a lot of forest reserve and little SAF; Farmer type 3) a lot of SAF and little forest reserve .

SOURCE: made by the authors (2019).

restricted to family farmers who had been practicing agroforestry systems for at least five years to ensure the inclusion of more established systems. After contacting the farmers indicated by the aforementioned institutions, the sample was expanded using the snowball method (Bernard, 1995), which consisted of one farmer indicating another and so on until the farmers mentioned were repeated. As a result, the sample for this study included 30 family farmers with SAF between the ages of 6 and 24, and these farmers lived in 21 communities distributed throughout the municipality (Figure 1).

This study is classified as qualitative and exploratory. Three different methods (structured interviews, illustrated questionnaires and *Likert* scales) were adopted as complementary data collection to understand the degree to which farmers perceive and value ecosystem services.

We tried to get around the methodological limitations of this study by adopting different approaches. During the construction of the *Likert* Scale sentences, in order to diversify and obtain answers that were more in line with the farmer's perception, we created sentences with both an affirmative and negative bias for each ecosystem service. We know that no method is capable of accurately extracting the complexity of the human personality and that the *Likert* scale method may have overestimated the farmers' assessment of ecosystem services. In any case, the combination and triangulation between the different methods offered more certainty about the patterns found in the study, with different approaches generally converging on the same results.

In order to understand which Ecosystem Services were most valued by farmers, an illustrated questionnaire with 16 types of illustrated ES belonging to the categories of support, regulation,

provision and cultural was used to rank the interviewees on a scale of 0 to 3.

In order to obtain a relative index of farmers' perceptions of ES, the *Likert* scale was chosen to capture more detailed perceptions and opinions on each service category. This method presents a scale of intensity of responses to a given statement in which the interviewees gave their degree of agreement (Likert, 1932). In this study, the intensity scale ranged from totally agree (score=5), partially agree (score=4), don't know (score=3), partially disagree (score=2) and totally disagree (score=1).

In order to characterize the farmers' recovery strategies (natural regeneration of the forest reserve and SAFs), exploratory analyses were carried out using averages and measures of data dispersion. The comparison between farmer typologies was based on comparisons of the average score on the *Likert* scale. The *Likert* scores per Ecosystem Service, which contained a positive and negative sentence, were added up, the arithmetic mean was obtained and the mean of the service category was then calculated.

A global typology was drawn up based on the proportions of SAF and regenerating forest reserves. Three groups were identified to compare the relative averages of perception:

- 1) Little SAF and little forest reserve area,
- 2) Little SAF and a lot of forest reserve area and
- 3) A lot of SAF and little forest reserve area (Table 1).

In this first analysis, we selected only the *Likert* sentences in which there was a standard deviation >1 between the answers, resulting in 10 sentences. Most of the sentences with the greatest

deviation (n=8) had a negative meaning in the questionnaire.

TABLE 1 - Typology of farmer groups by percentage of SAF area and forest reserve area.

Group	Type	Qty of Farmers
1)	Little SAF and little forest reserve area	18
2)	Little SAF and a lot of forest reserve area	5
3)	Lots of SAF and little forest reserve area	7

SOURCE: made by the authors (2019).

The data on the percentage of the area under restoration in relation to the total area of the property in hectares was obtained from the estimate declared by the farmers themselves. For forest reserves, we considered areas of natural regeneration (known locally as capoeiras), which the farmer had no intention of converting into agricultural activity at the moment or in the future. In general, farmers consider "forest" to be any area with substantial tree cover (Sasaki & Putz, 2009). We then considered the areas of capoeira (generally denser or "thicker") because many farmers no longer had native forest areas due to the limited coverage of the original forest in the municipality (only around 10%).

3. Results

3.1. Farmers' agroforestry systems and regenerating forests

The age of the SAFs of the family farmers studied ranged from 3 to 24 years (average = 12.37 years), while the area ranged from 0.33 to 7.5 ha (average = 2.2 ha). The proportion of FAS on the farm ranged from 0.5 to 60%, with a median of 5.1%. However, 70% of the farmers said they wanted to expand the SAF area in the coming years. The number of species in the SAFs ranged from 10 to 112 (median=20.5). However, three farmers had a much higher number of species, with 50, 70 and 120 species respectively, while the others varied between 10 and 40. The products most sold, according to the farmers, are various fruits. These include açaí, cocoa, cupuaçu, bananas, pineapple *in natura* or in pulp.

Around 18 farmers (60%) stated that they conserve capoeira areas mainly to obtain non-timber forest products. The reasons stated by the farmers for conserving the capoeiras in the long term were diverse, linked to environmental conservation such as forest recovery, protecting streams and springs, providing shelter for animals, extracting açaí and keeping bees.

3.2 Perception of ecosystem services by family farmers

Using the illustrated questionnaire method, in which the interviewees ranked the SEs in four degrees of appreciation, it was possible to obtain an

overview of the services that were most and least important to them (Figure 2).

Ecosystem services related to water (quality and quantity), which belong to the provision category, as well as the cultural service "feeling peace of mind" related to natural environments, were the ES considered to be the most valued and showed the highest frequency for the highest valuation score (score 3) given by farmers. Food production and diversification were also highly valued, with a high frequency of scores of 2 and 3, but they were

less valued than water services and peace of mind. On the other hand, regulation services to control soil erosion and pests/diseases, as well as the provision of various materials (wood, straw, lianas and medicinals) received the lowest frequencies for the highest valuation, and the highest frequency for the score that represented the lowest valuation (score 0). Therefore, these were relatively less valued in relation to the other services presented to the farmers studied.

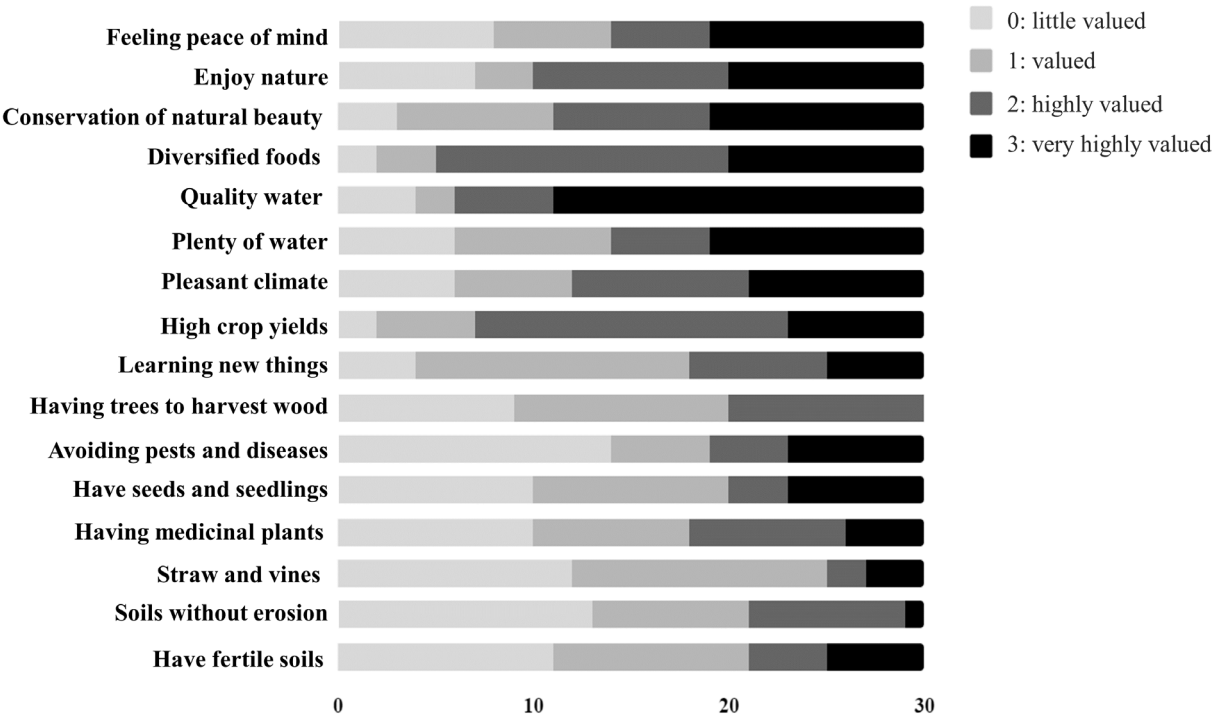


FIGURE 2 - Ranking of the ES most valued by family farmers practicing Agroforestry Systems in the municipality of Irituia, Pará (n=30). The ranking varies from 0 (least valued) to 3 (most valued). The ES evaluated cover the four categories of the *Millennium Ecosystem Assessment* (2005): provision, regulation, cultural and support.

SOURCE: made by the authors (2019).

3.3 Perception of ecosystem services by family farmers in relation to agroforestry systems and forest reserve areas

In general, when comparing SE categories, the averages were similar and high. The *Likert* scale scored from 1 to 5. When comparing the average responses between the three types of farmers formed by the relationship between the SAF area and the forest reserve area, we noticed that group 3 - little reserve area and a larger SAF area - had, overall, a higher frequency of positive averages than the other groups. This group obtained the highest score in seven of the ten sentences evaluated in relation to the other groups. Group 1 - with less forest reserve

and less SAF and less SAF - also had a high frequency of high scores, but was slightly lower than group 3. Group 2 - a lot of forest reserve and little SAF - tended to have the lowest mean SE perception scores of the three groups, with the lowest score for seven of the ten sentences evaluated compared to the other groups (Table 2).

When analyzing the relationship between the perception of ES and the variables, individually, percentage of FAS area, age of FAS and percentage of forest reserve area, we observed a significant correlation between perception and proportion of forest reserve area, and the correlation was negative (Kendall's tau (r) = -0.25; $p < 0.05$).

TABLE 2 - Comparison of SE perception averages for different categories based on a Likert scale with negative (-) and positive (+) sentences in order to verify the perception of family farmers in the municipality of Irituia, Pará.

Type of service	Category	Group 1 - Forest - SAF	Group 2 + Forest - SAF	Group 3 - Forest + SAF
(-) Education	Cultural	3.89	2.8	3.86
(+) Genetic Resources	Provision	3.94	3.8	4.57
(-) Food	Provision	4	4.2	4
(-) Fibers/active ingredients	Provision	3.39	2.8	3.43
(+) Fibers/active ingredients	Provision	4.11	2.6	4.43
(-) Genetic resources	Provision	3.33	3.4	4
(-) Pest control	Regulation	4.39	4.2	4;43
(-) Erosion control	Regulation	4.11	4.8	4.86
(-) Animals/existence	Regulation	4.78	4.2	5
(-) Nutrient cycling	Support	4.39	4	4.86
Mean±SD		4.03±0.44	3.68±0.74	4.34±0.51

SOURCE: made by the authors (2019).

3.4 Farmers' motivations for forest recovery and the implementation of SAFs

The spontaneously cited motivations for starting SAFs are diverse, especially for food security and marketing products, with 30.95% and 23.81% of farmers, respectively (Figure 3). On the other hand, there was a diversity of motivations that can be linked to the various Ecosystem Services, including quality of life (11.90%), reforestation (9.52%), appreciation for trees (7.14%).

We observed that all the farmers studied see a relationship between the SAF they have planted and environmental recovery, using terms such as "reforest" and "recover" to refer to them, as transcribed below: *I feel proud of **reforesting** the area*

by planting SAF. Every tree helps. [Farmer, 59 years old]. Yes, **recovering** means saving more money by having more food and I won't have to cut down or burn the area, because it's a shame to end up planting [Farmer, 75 years old]. I **reforest** with fruit plants, it provides shade and is cooler [Farmer, 66 years old]. *SAF is the only way to **reforest**, because you plant, you have standing trees and food to eat. The example of **reforestation** is here, imitating the forest. And it brings a lot of people to see it* [Farmer, 60 years old]. I'm certainly **reforesting**, as many animals have come and the land has become more productive [Farmer, 59 years old].

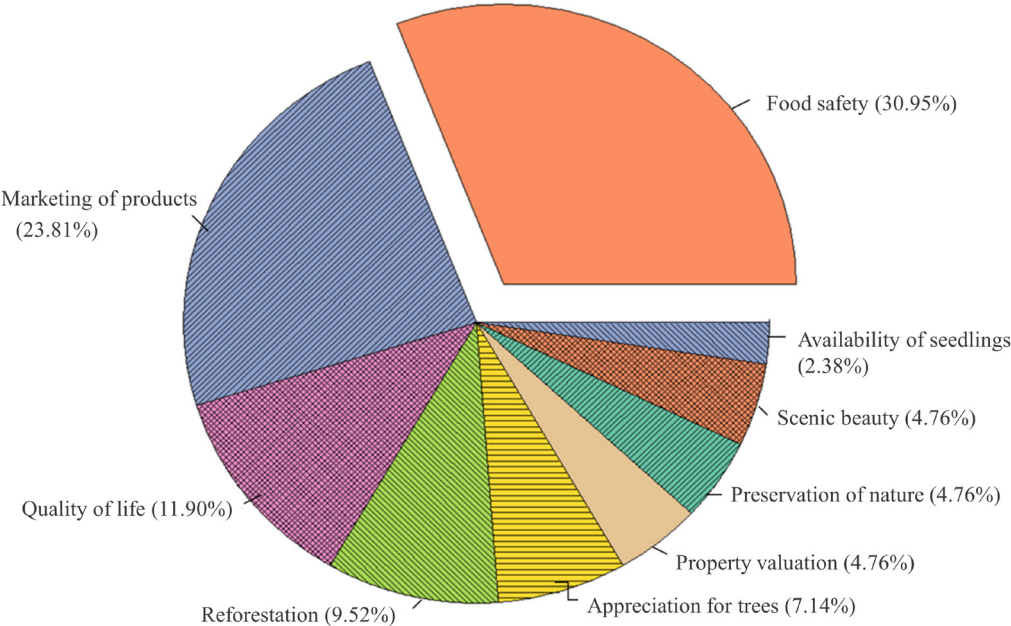


FIGURE 3 - Motivations stated by family farmers in Irituia, Pará, for implementing Agroforestry Systems (n=30).
SOURCE: made by the authors (2019).

4. Discussion

Our results showed that farmers, in general, had high average perceptions for all types of ES, assigning high values on the *Likert* scale. This can be attributed to family farmers' deep experiential knowledge of their systems, in which various Ecosystem Services are managed directly and indirectly (Teixeira *et al.*, 2018).

Of the family farmers (n=30) interviewed in Irituia, Pará, only four were female while the rest were male (n=26). Most of the sample had an average age of between 41 and 60 (n=20). The level of schooling did not vary greatly, with 24 (80%) of the farmers having up to primary education. It should be noted that 28 (90%) of the farmers were born in the state of Pará, more specifically in municipalities belonging to the northeast of the state (Irituia, São Miguel do Guamá, Capitão poço and Mãe do rio), and have lived in the region for more than 20 years, which probably influences the high perception we observed of the SE. The importance of origin and length of time living in the locality on the local perception of ecosystem services was demonstrated in the study by Fagerholm *et al.* (2012) on farmland and forest reserve areas in Tanzania, Africa. In the study by Fagerholm *et al.* (2012), the individuals with the highest perception of Ecosystem Services had lived in the locality for at least 10 years and tended to rate their self-perceived knowledge with the highest scores.

Our study showed that cultural ecosystem services, such as providing peace of mind and natural scenic beauty, were as valued by Irituia farmers as food provision services. This pattern was also found in backyard farmers in Spain, for whom cultural

services such as the heritage value of backyards and biodiverse space for coexistence were equal to the provision of food itself (Calvet-Mir *et al.*, 2012). These results are relevant if we consider that cultural ecosystem services tend to be neglected by development agencies and forest restoration promoters. In general, they assume that farmers are only interested in income and food production, and these services are not listed as a priority when making decisions (Milcu *et al.*, 2013).

Our results, obtained from the illustrated questionnaire, did not indicate that the local climate was one of the ecosystem services prioritized by the interviewees. This result was surprising at first glance. Climate change is already a reality in the Amazon region, especially in the most deforested areas, such as the northeast of Pará (Gatti *et al.*, 2021). On the other hand, it is possible that the very high importance given to ecosystem services related to water, which received the highest score from farmers, may be precisely a reflection of the drier climate in the region in recent decades. In fact, there were reports of a perceived increase in the ambient temperature over the years. This change has led farmers to alter their work schedules because of the high temperatures. Furthermore, the *Likert* scale score for climate regulation was high (X 4.90) indicating that farmers relate the presence of trees to climate change mitigation. Therefore, it is possible that the climate questions in the questionnaire were not comprehensive enough to capture their importance.

We observed that, in general, the provisioning category received the lowest overall average relative perception (X 4.31) among all ecosystem services. On the other hand, as mentioned earlier, provisioning services related to water (X 4.93), as

well as the appreciation of its quality by farmers, were identified as a priority service by both methods used (*Likert* scale and illustrated questionnaire). Despite the abundance of water in the Amazon region in general, this perception of water may actually reflect sensitivity to the changes that the most deforested areas have undergone. The municipality of Irituia, for example, has less than 11% remaining forest cover. The decline in water quality in northeastern Pará, influenced by deforestation, agricultural practices such as slash and burn and the formation of pastures in drainage areas, has been revealed by various studies (Veronez, 2011; Barroso *et al.*, 2015). Water was also the main ecosystem service perceived in forest restoration projects in southeastern Brazil (Brancalion *et al.* 2014), a highly deforested region that has suffered from severe droughts in recent years, which have been widely reported in the national media.

In addition, our results also showed that the farmer with the highest perception of ecosystem services is the one with the smallest area of forest reserve (Kendall's Tau (r) = -0.25; $p < 0.05$) and possibly the largest area of SAF. In this way, it can be hypothesized that a greater perception of services is linked to the absence of forest areas, to a greater appreciation for the loss and lack of their attributes. In addition, the practice and experience with the SAF as a way of recovering these attributes may have a positive influence on the perception of ecosystem services. Family farmers, in comparison to large-scale farmers, implement and manage the SAF according to their perception, with a strong environmental focus, and demonstrate a great deal of knowledge about species mix and economic benefits (Pompeu *et al.*, 2017).

Local biodiversity in SAFs is still relatively low considering the great floristic richness of native forests in the Amazon region (Ter Steege *et al.*, 2019). Farmers plant according to the supply of seedlings in the region and depend on the supply of seedlings made available by the Irituia Municipal Department of Agriculture and local cooperatives. Considering that the institutions fundamentally prioritize fruit species with the highest commercial value, efforts should be made to support family farmers in expanding the diversity of multi-purpose native species that meet the multidimensional interests of ecosystem services demonstrated in this study.

Some species stand out in the SAF arrangement, such as açaí, cocoa, cupuaçu and banana, which are the most produced and distributed by technical assistance institutions and local cooperatives. Among these, the açaí species has been most widely used and distributed to farmers, encouraged by the strong demand for the product in the markets (Homma *et al.*, 2006; Steward, 2013). For example, changes in agricultural practices and agrobiodiversity patterns have been observed in settlements in Amapá and caboclo communities in Amazonas (Steward, 2008; 2013).

Investment in research into agrobiodiversity in productive agricultural systems can guide public policies and effective actions to minimize the effects of the loss of diversity, as this is directly related to the quality of life and food security and stability of agricultural systems (Machado *et al.*, 2008). Therefore, by developing strategies to encourage this, farmers would have greater agrobiodiversity within the SAFs. Considering all these issues, efforts should be made to support family farmers in expanding the diversity of native, multi-purpose species that meet their multidimensional interests in

ecosystem services (cultural, provision, regulation and support), as demonstrated in this study.

5. Conclusions

The ecosystem services that were relatively more valued by the family farmers studied were water (quality and quantity), which belongs to the category of provision; and the cultural service of peace of mind related to natural environments. On the other hand, the services of regulation to control soil erosion and pests/diseases were relatively less valued than the others presented by the farmers studied.

The main motivations for family farmers to recover forests through SAFs is prioritized by food security and the marketing of products, and all the farmers studied see a relationship between the SAF they have implemented and environmental recovery. The maintenance of regenerating forests by farmers is based on aspects linked to the provision of ecosystem services. These include the advantage of having food for family consumption, timber species, species for planting trees on the property, seed collection, shelter for fauna and species for hunting.

The smaller area of forest reserve and the larger area of agroforestry system were related to higher perceptions of ecosystem services, suggesting that the loss of forest area possibly leads to a greater awareness of the benefits of natural systems, and the increase in SAF areas is an attempt to return the functions and benefits lost through environmental degradation over time.

Farmers understand that the SAFs they manage contribute to forest restoration. However, they lack support programs to strengthen the capacity of SAFs

to provide more ecosystem services, particularly biodiversity.

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