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SMALL ORGANIC FARMING: THE CASE OF PEPPER (*PIPER NIGRUM* L.) VALUE CHAIN IN SÃO TOMÉ AND PRÍNCIPE

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ABSTRACT: *Organic agriculture, in addition to supporting environmental sustainability, has been a meaningful way to protect and develop small farming in developing regions. The changes that have occurred within the value chain, such as increases in global standards and the effect of globalisation, have created an increase in both opportunities and risks for smallholders. In the developing countries, mainly on African continent organic agriculture beyond being less researched than in the developed ones, there are constraints related to scale, certification policies, strategies, and the fact that most farmers remain in informal circuits. This paper presents a study of the pepper value chain in São Tomé e Príncipe, which is divided into two categories: certified organic producers, affiliated (Aff) to the Cooperative of Pepper and Vanilla Export (CEPIBA) and non-certified organic pepper, non-affiliated farmers (Naf). The study presents the strategy to promote organic farming through the value chain and a brief comparison among certified and non-certified organic producers. The results showed that Aff perform better than Naf because they have financial stability and apply sustainable practices that are more productive and provide better income, while Naf generally practice subsistence farming with the exception of some medium enterprises.*

KEYWORDS: value chains, certification, environmental, organic farming, pepper, smallholder.

INTRODUCTION

The new framework and dynamics of food chains (FCs) are a consequence of globalisation and the liberalisation process that began in the mid-1980s (Hatanaka *et al*.,

2005; Mergenthaler *et al*., 2009; Reardon *et al*., 2009). Deep vertical coordination, food standards based on quality and food safety and increasing concern regarding ethical and environmental principles and animal protection are the main organisational and institutional changes faced by FC actors such as smallholders (Swinnee *et al*., 2013). Similarly, specific certification systems such as organic farming and fair trade have been broadly applied to small farming with the aim of reducing poverty, promoting sustainable farming practices and improving income for smallholders and their communities (Kleemann and Abdulai, 2013; Oscar *et al*., 2015). However, the certification policies and the technical and financial support are more effective when the partners such as NGOs, donors, and the private sector act in partnership for the medium and long term.

Super- and hypermarkets dominate the food supply chains in developed countries, and their share in developing countries is rapidly increasing. Regarding African countries, their high-value products continue to be targeted to European markets, as local consumption of these products is low (albeit exhibiting an upward trend). In this sense, two actions are necessary; (i) promoting the consumption of organic products and (ii) establishing supplying contracts with smallholders because they are the majority, and these actions can improve the income.

On the other hand, which concerns the export of certified products, African countries must continue to develop and apply global quality standards to attain full participation in international markets (Trienekens and Zuurbier, 2008). This process should also be accompanied by the development of national legislation for organic agriculture (OA). There are only two African countries with national legislation for OA, although legislation is in progress in seven other countries (FiBL and IFOAM, 2019). This challenge requires the support of NGOs and local governments, which could make the large-scale conversion of farmers to OA more efficient since the cost of certification is higher for smallholders and often feasible only with the support of NGOs and exporters, as argued by Kleemann and Abdulai (2013).

While Africa has the smallest area of certified organic agriculture, it has the second highest number of organic farmers (FiBL and IFOAM, 2019). Therefore, the development of certifications, such as a certification for OA, is strategic for these farmers that generally are excluded from global value chains (VCs) due to (i) high transaction costs, (ii) lack of access to capital and (iii) poor skills and managerial capacity to absorb technical and financial assistance (Swinnee *et al*., 2013). These specific markets and their products translate into an increasing demand that is strategic for smallholders, as these products offer higher income and better trade circuits (Pimentel *et al*., 2005; Chiputwa *et al*., 2015; Seufert *et al*., 2017).

Particularly in developed countries, consumers who are willing to pay more for organic or fair-trade products are typically concerned with the protection and sustainability of natural resources (Trovar *et al*., 2005; Kleemann and Abdulai, 2013), health issues or product features such as freshness and taste (IFOAM, 2013; Annunziata and Vecchio, 2016). For poor, developing countries, certification systems are an advantageous strategy because they are inclusive and broad insofar as they reflect social, economic, and environmental issues (IFOAM, 2013; Oelofse *et al*., 2010). The messages should focus on environmental protection and health to attract consumers, which seems local consumers are concerned about.

Evidence has been shown that sustainable practices under OA improve ecosystem resilience (Bolwig *et al*. 2009). With exception from economic benefits, other advantages of OA, such as social and environmental, are sometimes difficult to explain to farmers. They are appreciated only in the long run (Kleemann and Abdulai, 2013) and are usually not quantified. Thus, to attract and engage farmers, campaigns should focus on explaining two points: (i) the reduction of inputs and labour demand in OA tend to be less costly than that in conventional farming (Pimentel *et al*., 2005; Oelofse *et al.*, 2010) and (ii) the technical advantages of converting to OA (Fairweather, 1999) benefit soil quality and include improved resilience to climate changes, according to the report by IFOAM (2013).

On the other hand, many organic farmers in Africa are organic by default and exhibit little concern about OA or sustainable practices (Bolwig *et al*., 2009; IFOAM, 2013; Kleemann and Abdulai, 2013). In this concern, two questions may stand up: they are taking all advantages of OA? Are they prepared to fill the requirements to join a given value chain? So, the answer is technical support for them, followed by a very closed monitoring process.

The bulk of organic production zones are in Asia and Latin America, and the demand for organic products remains high in Europe and North America (Parvathi and Waibel, 2016). Because of this exportation and high global demand, there are more opportunities and benefits for smallholders to convert to OA. What is also needed is to involve more and more private companies from these desired markets as development partners and/or promoters of investment. This issue is more relevant in African countries than in other developing regions such as Asia and Latin America, which have benefited from the technological advantages of the past century's green revolution. As Africa's value chains are developed to respond to the demand from developed countries with tenuous effects on local food security (IFOAM, 2013), the economic and social involvement of external company can have a positive impact on the local economy.

Pepper production in São Tomé e Príncipe (STP) and in other countries such as Brazil, India and Indonesia is dominated by smallholders who often operate in unfavourable rural zones (Manohara *et al*., 2004; Partelli, 2009). The dried pepper is currently exported to European markets, where organic pepper from STP has been well received. In STP, the pepper sector has two sub-chains: affiliated farmers (Aff) associated with the Cooperative of Pepper and Vanilla Export (CEPIBA), who represent value chain 2, and the group of individual producers called non-affiliated farmers (Naf), who compose value chains 1 (e.g., the informal sector).

Agriculture remains the main source of African exports and has been attracting investment from both retail and agri-food industries (IFOAM, 2013). In sub-Saharan Africa, for example, the development of high-value chains is an opportunity to generate income, which can alleviate rural poverty. That is why in STP, the African country with the largest relative organic farming area and the 5th in the world (FiBL, 2017), OA is not only a market issue but also a policy strategy to promote rural development and support small farming.

Organic farming is much less well-studied in developing countries than in developed ones, and many studies have focused their analyses on certified versus conventional farmers. However, it is also important to analyse the 'organic by default producers', i.e.,

those who do not use chemicals or other new technologies due to a lack of resources. These producers constitute a significant portion of the informal sector, which is dominant in Africa. To fill this research gap, this paper analyses the pepper production sector in STP, starting with an overview of Aff and Naf, followed by a review of pepper production systems, labour and farmer characteristics such as gender and age. Second, we evaluate correlations between responses or dependent variables (production and yield of Aff) and several independent variables (e.g., age, number of plants, time in production.). Finally, a short comparative analysis of the social and economic factors between the two groups is provided.

METHODS AND CONCEPTUAL FRAMEWORK

2.1. Conceptual framework

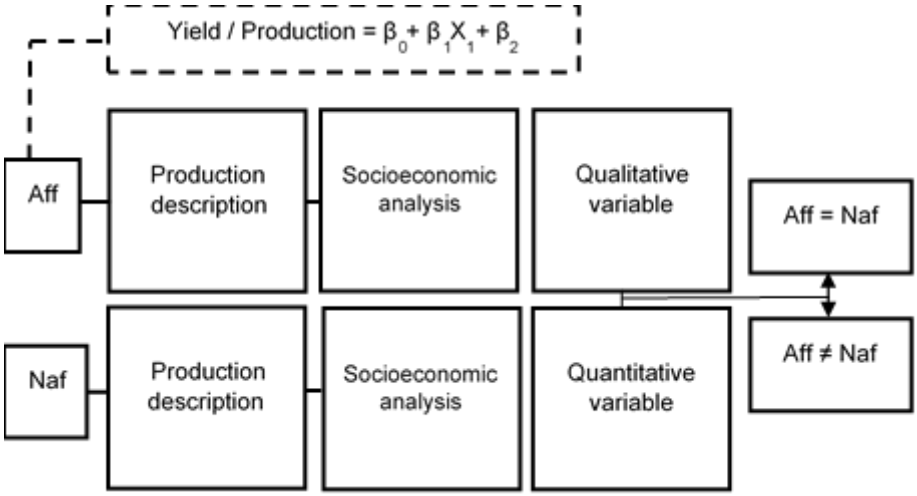

Figure 1. Conceptual framework

According to the conceptual framework, the linear regression was only applied for Aff group due to the little data available for Naf. Secondly, the paper provides a description of Aff and Naf, which concerns their production characteristics and economic and social issues. Finally, a comparison between Aff and Naf is provided based on a set of qualitative and quantitative variables.

Study area

Although pepper production occurs throughout the country, with the exception of the Caué district, most producers are located in the districts of Lobata and Mé-Zóchi, especially in the northern and eastern sides of São Tomé (Figure 2).

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Figure 2. Distribution of surveyed affiliated farmers (Aff) and non-affiliated farmers (Naf) by district in São Tomé Island. The localisation point, in orange, is the processing centre of Rio Lima, which belongs to Aff. The red numbers are Aff, and black numbers are Naf. Source: https://d-maps.com/carte.php?num_car=27635&lang=en (Accessed in 05/11/2020)

Due to climate conditions, there are more producers in the east and north of São Tomé. In higher rainfall zones in the south, precipitation can reach 6000 mm per year, which can promote the emergence of diseases and worsen access to agricultural plots in those communities. Moreover, in the central zone and its frontier, there are established producing communities where cultivation of crops could be extended.

Table 1. Number of farmers and communities of affiliated farmers (Aff) and non-affiliated farmers (Naf).

Districts	Nº of farmers		Nº of communities	
	Aff	Naf	Aff	Naf
Lobata	25	4	3	1
Água Grande	6	1	2	1
Mé-Zóchi	32	10	9	6
Cantagalo	13	3	8	3
Lembá	6	1	1	1
Caué	0	0	0	0
Total	82	19	23	12

As indicated in Figure 1 and Table 1, all study communities are located between the north and east sides of São Tomé. Districts with more producers are close to the processing centre in Rio Lima; however, there are few access routes between them.

Data collection

Data were collected through surveys and interviews. Local sources of information, such as reports and books, were also considered. Surveys were conducted from August to December 2017.

One hundred and one surveys were carried out during the fieldwork, 82 with Aff and 19 with Naf (Table 2), and 17 interviews were conducted with stakeholders involved in both circuits (informal and formal from CEPIBA). The cooperative covers both islands, São Tomé and Príncipe, but the surveys were conducted only on the main island of São Tomé.

Table 2. Main indicators [age, production, area, producers, gender and communities] for affiliated farmers (Aff) and non-affiliated farmers (Naf) of the Cooperative of Pepper and Vanilla Export (CEPIBA) on São Tomé Island.

Producers	Surveys	Gender (%)		Age		Area (ha)	Production of fresh pepper (t)	Communities
		M	F	Mean	Median			
Aff	82	79	21	54	55	57.64	16.895	23
Naf	19	89	11	52	56	9.18	2.235	12
Total	101	82	19	-	-	66.8	19.13	35

According to PAPAFPA and FIDA (2011), there were 22 individual producers, the so-called Naf, of whom 19 were surveyed for this study.

In 2017, there were 333 producers (old and young) affiliated with CEPIBA (Aff), of whom 82 (24.92%) were surveyed.

In 2017, the total amount exported by CEPIBA was 16 tonnes of dried pepper. The conversion factor of fresh to dried pepper is 0.9 (CEPIBA staff through interview); thus, the production of fresh pepper should be approximately 17.8 tonnes. The registered production of fresh pepper from surveyed Aff was 16.9 tonnes.

Statistical analysis

The statistical analysis was completed in Software R version 3.5.2 (R core Team, 2017). For qualitative variables, Fisher's exact test was used, while the Mann-Whitney (Wilcoxon rank-sum) test was used for quantitative variables. Results were considered significant at * p<.1, ** p<.05, *** p<.01.

First, through multiple linear regressions, the correlation between each of the response variables (production and yield) and the independent variables (see Table 3 above) was determined. The following types of equations were calculated.

$\mathbf{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots + \beta_n X_n$

The independent variables for these two equations are defined below in Table 3.

Table 3. Description of variables and their units.

Variable	Units	Acronym
Productivity	kg\ha	Prodt
Production	Kg	Prod
Age	Year	Age
Number of household element	Person	Hhele
Crop number	Unit	Cropn
Hour of labour	Hour	Whour
Number of workers	Person	Wokn
Time in production	Year	Proti
Age of crop	Year	Croag
Schooling level	Success year	Slev
Other activity		Owok
Agriculture failure		Agfai
Own car		Ownc
Reform		Ref
Work plan		Wokp
Parent help		Phelp
Manure adding		Madd
Irrigation of all crops		Irr
Irrigation of new crops		Irrnew
Consociation		Co.n

Note: Work plan – means the type of management (permanent or seasonal). Agriculture failure – means weak production due to biotic or abiotic factors. Success years – means the years of education successfully completed.

When analysing the global results for both Aff and Naf, the objective was to compare and identify differences among these two sets of producers through the statistical tests described above.

RESULTS

Correlation among variables

i Production

Table 4. Summary statistics of the data used in Aff production response regressions.

Parameters	Estimate	Std. Error	Statist t	p-value
β_0	-241.87075	113.53537	-2.130	0.040246**
β_1 (Prodt^{eq})	0.15939	0.03763	4.236	0.000157***
β_2 (Wokn)	133.426811	32.45247	4.111	0.000226***
β_3 (Proti)	-28.16811	16.31374	-1.727	0.093049*
β_4 (Croag)	74.47898	21.14921	3.522	0.001214***

Note: Significant at * p<.1, ** p<.05, *** p<.01. Multiple R-squared=0.7654 \ Adjusted R-squared=0.7385

The variables that explained production variability were equivalent productivity (Prodt^{eq}), number of workers (Wokn) and age of the plant (Croag), which had positive effects, and a farmer's time in production (Proti), which had a negative effect. Proti was significant only at the 10% level. Croag was positive, likely because, according to Ferrão (1999), the

yield per plant increases from the first fruiting until the plant reaches 10 years old. The opposite was found for the length of experience of farmers, probably due to the low production of the oldest producers who have been producers for a longer time.

Yield

Table 5. Summary statistics of the data used in Aff yield response regressions.

Parameters	Estimate	Std. Error	Statist t	p-value
β_0	1302.0372	180.1597	7.227	$1.21*10^{-8}$***
β_1 (Prod)	2.2857	0.2183	10.469	$9.40*10^{-13}$***
β_2 (Areaeq)	-2144.3054	342.5685	-6.259	$2.51*10^{-7}$***

Note: Significant at * p<.1, ** p<.05, *** p<.01. Multiple R-squared=0.7717 \ Adjusted R-squared=0.7597

Only production (Prod) and equivalent area ($Area^{eq}$) explained yield variability. These variables represented an increase in yield of 0.2 and 343 kg per production unit (1 kg) and $Area^{eq}$ (1 ha), respectively.

Production characteristics

The pepper production system in STP

The pepper production sector in STP is divided into two sub-chains: VC1 – non-certified organic farmers, i.e., farmers not affiliated with the cooperative (Naf), and VC2 – certified organic farmers, i.e., affiliated farmers (Aff). VC1, the informal sector, covers all national circuits, including small amounts exported to neighbouring countries such as Gabon and Angola. VC2, the formal sector, was developed by a public-private partnership with the support of foreign organisations such as the International Fund for Agricultural Development (IFAD) and the French Development Agency (FDA) with the aim of increasing the exportation of certified agricultural products to international markets and organising the smallholders in cooperatives, as in the case of CEPIBA.

Regarding VC1, the lack of data makes it more difficult to apply market rules and avoid, for instance, illegal competition, which can be a threat to VC2 and which impairs the development partnership mechanisms between these two sub-chains and the implementation of efficient policies for the entire pepper sector.

Main pepper indicators for the VC1 (Naf) and VC2 (Aff) sub-chains

Concerning the share of household income due to pepper, only 20% of Aff and 10% of Naf use pepper as the main source of income. This discrepancy occurs because the agricultural system is dominated by family subsistence farming; as a result, pepper is cultivated in mixed-crop systems with other dominant and more viable crops, such as cocoa and coffee. The surveys showed that approximately 52% of Aff and 32% of Naf are also producers of cocoa, vegetables and/or palm wine from spontaneous and old plants.

Among Naf, 32% used to be Aff, and they left the cooperative due to low quality of seedlings and the management of their distribution, low production, and lack of technical support and input supply, and in some cases, the farmers just wanted to leave.

To join the cooperative, each community must have at least 15 farmers, which is a limitation for some interested farmers. Other farmers prefer to work alone or have received little information about how the cooperative functions.

A large number of Aff view the cooperative only as a means of obtaining technical and financial assistance. It is essential to increase the awareness among farmers that the cooperative should provide more than that, namely, that it should function to obtain the scale required to be a player in the international market.

Strengthening the CEPIBA requires training efforts and the dissemination of information about association objectives and community living. These improvements are essential and beneficial because, according to staff from the cooperative, there are engaged farmers who are likely to pay quotas, promote mutual help and elect more women as cooperative staff.

Types of systems for pepper culture

For the scope of this paper, the pepper-producing system was divided into three groups (A, B and C). This division was based on three criteria: the location of the plots versus farmers' households, pepper production in mixed-crop systems and pepper production in monoculture.

i) A – Family production close to the farmers' house (Aff – 30%, Naf – 47.3%);
ii) B – Cultivated with cocoa, coffee and other food crops (Aff – 60%, Naf – 47.5%);
iii) C – Cultivated with pepper monoculture (Aff – 10%, Naf – 1.2%).

The most common system was B because cocoa and coffee are historically important cash crops in the predominantly subsistence farming system in this country.

Agricultural operations of the VC1 (Naf) and VC2 (Aff) sub-chains

In agricultural operations, several cultivation tasks are vital for the maintenance of pepper plantations and their sustained productivity (see Table 6). The analysis showed, as expected, a significant difference between Naf in VC1 and Aff in VC2, which was explained by the percentages of farmers who do not apply the main pepper agricultural practices, as well as by the resources used and the ways in which these practices are applied.

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Parameters	**Manure**	**Cutting**	**Pepper pruning**	**Tutor pruning**	**Mulching**	**Pest and disease control**	**Irrigation**	
Type of producers	Origin	Buyers (%)	Equipment	Equipment	Resource	Resource	Water source	Technology
VC1/Naf	Animal: caprine, chicken. Vegetal: *Musa spp.*, *Teobroma cacau.*	0	Knife, pruning shears, katana.	Katana, hook.	Musa spp.; other herbaceous.	Products (ash, quicklime (CaO), palm oil).	River, rain, public.	Bucket, garden hose, watering can.
VC2/Aff	Animal: bovine and chicken Vegetal: *Musa spp*.; *Theobroma cacao* L.; *Flemingia macrophylla*; *Erytrina sp*.	6	Knife, pruning shears, katana.	Katana, chair, hook, hacksaw.	*Musa spp*.; *Flemingia macrophlla*; *Elaeis guineensis;* other herbaceous.	Products (ash, palm and cocking oil, quicklime (CaO)) Plants (Malagueta *pepper*, *Azadirachta indica*) Operations (pepper and tutor pruning, removal of infected plant, cleaning).	River, rain, public, and buying.	Bucket, garden hose, watering can, drip irrigation, sprinkler irrigation.

Table 6. Agricultural operations by the type of value sub-chain (VC1 and VC2) belonging to affiliated farmers (Aff) and non-affiliated farmers (Naf).

Note: Buyers represent the percentage of farmers in each group who buy cuttings for replanting or to create new plantations.

Regarding applying manure, pruning pepper plants, and staking and mulching, the operations were similar for both VC2/Aff and VC1/Naf, and they used almost the same resources. For irrigation and pest and disease control, compared to VC1, VC2/Aff had more advanced equipment, such as drip and sprinkler irrigation systems, and more technical options for pest and disease control. The mulching techniques used by VC2/Aff included the use of plants recognised for their potential to promote soil fertility, thus assisting with medium- and long-term management of farms. The water source used for irrigation in both of the producer groups was strongly dependent on climatic conditions, the proximity of the plot to a river and the national water distribution network. VC1/Naf performed subsistence farming with a nearly complete absence of investment, where the main activity was harvesting. Comparatively, VC2/Aff needed to invest not only in the harvest but also in water for irrigation during the critical phases of plant development, such as transplantation and fruiting.

More than 50% of VC1/Naf did not implement some of the main pepper cultivation operations (Table 7), which reinforces the argument that pepper is a secondary crop for the majority of VC1/Naf, as explained in some interviews.

Table 7. Percentages of farmers who did not perform the main pepper cultivation tasks.

Farmers group	Main pepper cultivation tasks (%)				
	Manure	**Pruning**	**Mulching**	**Pest and disease control**	**Irrigation**
Aff	6	4	7	30	30
Naf	32	32	60	52	32

Regarding VC2/Aff, the number of farmers not completing the main pepper cultivation tasks was notable only for pest and disease control and irrigation. That the farmers did not undertake these tasks cannot be considered entirely their responsibility due to the irrigation conditions mentioned above and the limited solutions offered by extension services and the CEPIBA technical team, particularly with regard to solving phytosanitary problems.

Types, common names and genera of plants associated with pepper

Generally, there are three different crop types planted in pepper plantations: food, export and horticulture crops. The most common food crops were banana (*Musa sp.*), cassava (*Manihot esculenta Crantz*) and matabala (*Xanthosoma sagitifolium*) (Vaz and Faustino, 2007; Ministério do Ambiente e Recursos Naturais de STP, n.a; Kamanda *et al.*, 2020). The export crops consisted of cocoa (Theobroma cacao) and coffee (*Coffea* sp.). Additionally, farmers had tropical fruit trees, such as papaya (*Carica papaia*), mango (*Mangifera indica*), avocado (*Persea americana*), guava *(Psidium guajava*), jackfruit

(*Artocarpus heterophyllus*), safuzeiro (*Dacryoide edulis)* and cajamangueira (*Spondias Cytherea Sonner*), within their pepper plantations (Vaz and Faustino, 2007; Ministério do Ambiente e Recursos Naturais de STP, n.a).

Labour and gender

In family farming, the number of family workers is higher than the number of hired workers. Our surveys revealed that both groups could be labelled as family farming because only 30% of the jobs in VC2/Aff were hired, fixed jobs, and 20% of the jobs in VC1/Naf were temporary jobs. The contribution of the farmers' parents was approximately 20% for both Aff and Naf, thus indicating that the farmer him- or herself performs the bulk of the activities. These results coincide with data presented at the latest seminar on national family farming in 2017, which showed that the share of agricultural production supplied by family farming in STP was approximately 80%.

Among these two groups of producers, women represented 30% and 9% of hired, fixed labour for VC2/Aff and VC1/Naf, respectively. Broad family support can reduce the labour costs of OA, as argued by Kleemann and Abdulai (2013).

The activities performed by the farmers' families were usually harvesting, weeding and agricultural treatments, and these tasks were shared with temporary workers. The latter also carried out activities such as ground preparation, pruning and planting. Pepper pruning is almost always performed by the farmers themselves, as the practice requires careful attention, technical skills and training.

Age was a concern for cooperative staff and donors because most of the farmers were over 50 years old (Figure 2). In the case of Aff, the CEPIBA, through donors' recommendations, is avoiding the conversion of new farmers who are older than 50 years of age. Accordingly, the survey results suggested that young people exhibit little interest in agricultural activities in rural zones. Even among Aff with economic guarantees, older farmers dominated the chain.

In STP, the retirement age is 62 for men and 57 for women. Thus, 10 years from now,

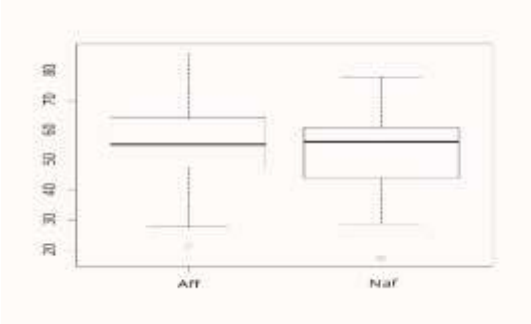

Figure 3. Box plot of ages of farmer groups (affiliated farmers (Aff) and non-affiliated farmers (Naf)). Aff (1st quartile (Qu): 45.5, 2nd Qu: 55, 3rd Qu: 64), Naf (1st Qu: 44, 2nd Qu: 56, 3rd Qu: 61) more than 75% of farmers in both groups will reach retirement age, which is a problem for production and a risk for CEPIBA consolidation.

Social analysis

Additionally, the recurrence of extreme events such as long dry seasons also requires new approaches to protect smallholders beyond the promotion of resilient farming.

i. Support from the wife according to different types of tasks

The role of women in VCs is important, and in the case of VC2, their contributions have been recognised, although this is still not reflected in the entire chain (see Table 8).

Table 8. Contribution of wives in the production and supply chain.

Tasks	Group of producers	
	VC2/Aff (%)	**VC1/Naf (%)**
Decision-making	1	0
Sale	1	0
Follow up the works, field tasks and other	51	42
None	24	32
Head of exploration	17	0
None or not answered	6	26

A significant percentage of farmers' wives engaged in off-farm activities, such as housework and activities outside the home, such as trade, cleaning and school support services. Similarly, approximately 40-50% of farmers' wives provided their support to the farmers on a daily basis, which is in accordance with findings that among Aff and Naf, 20-30% of their workers are temporary or fixed, hired workers. Regarding planning and decision-making, the data showed results for only VC2/Aff wives, probably due to the consolidation of the VC, which is not relevant in VC1/Naf.

Road conditions

Accessibility to the community is vital for agribusiness development. The fragile economy of STP has a dual dependence on external factors: first, financing is needed for the national budget, and second, the economy is very sensitive to the international political and economic climate. Hence, it is not surprising that the allocation of resources for infrastructure such as roads is scarce, as evidenced by the low level of asphalted roads (Figure 4).

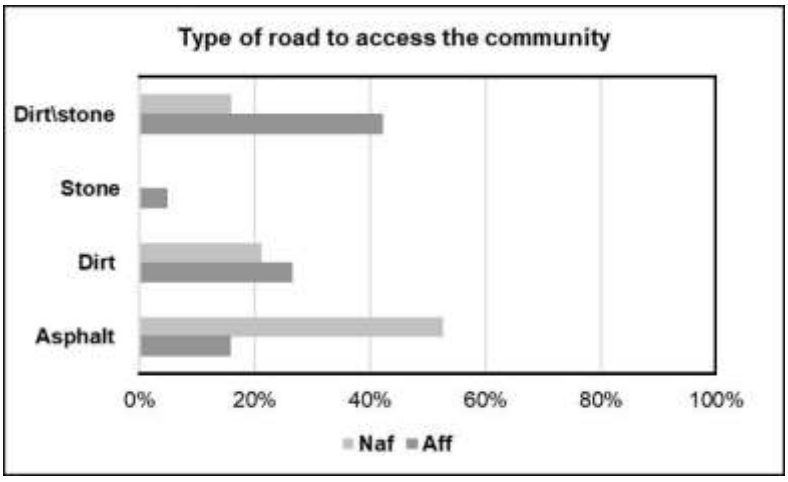

Figure 4. Types of road building to access the communities of Aff and Naf. These percentages represent the access only to communities that are in the centre of each agricultural community.

Figure 4 shows that the percentages of roads with asphalt for Naf were higher than those for Aff because Naf communities are closer to the capital. Therefore, Naf benefit from more asphalted roads. Dirt/stone roads are present in more than 40% of Aff communities, and this access is reasonable. The asphalted roads, however, are in poor condition, which compromises the transport of goods, especially perishable goods. These data are essential for two reasons: (i) for evaluating accessibility to the main productive zones around the country and assessing constraints to develop the VC and (ii) for identifying problems and framing them into agricultural policies and projects.

Land tenure

The process of 'land concession' began in the 1980s within the framework of agrarian reform, which resulted in public concession being the current major type of land tenure. The market for land rental and sale is almost non-existent because agriculture is largely practised by former agricultural state workers who now have the right to land use. Finally, the number of farmers with land is increasing, and this increase may suggest that people in other sectors of activity are showing interest in agricultural activities.

Regarding landowning, it is important to underscore that many Naf using pepper system A (family production close to the farmers' house; described in point 3.3) have their plot in the area of the household. Some Aff also use this same pepper system (A), but there are fewer Aff than Naf, and this is one reason explaining the differences in land tenure.

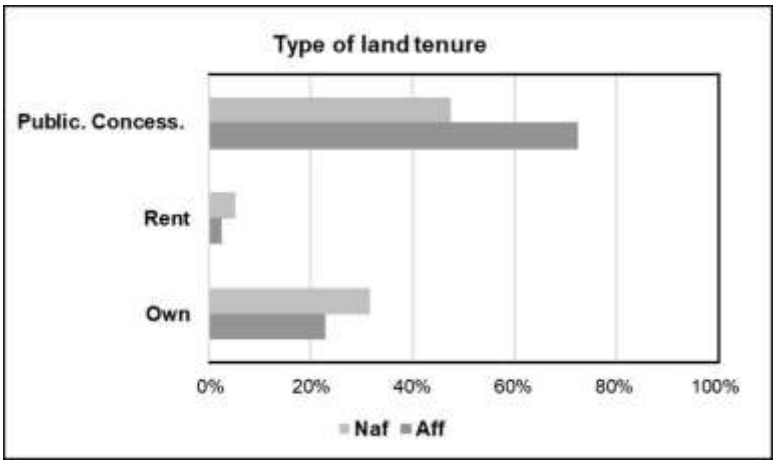

Figure 5. The main types of land tenure for Aff and Naf. Public Concess. means public concession.

In STP, the agrarian reform implemented amidst the structural adjustment programme created a system of land tenure that aimed to improve food security, increase and diversify agricultural production and mitigate poverty through the concession of public, agricultural land to smallholders.

Economic analysis

Distribution of pepper revenue by household type of expenditure

The farmers evaluated the use of pepper income using a growing scale from 0 to 5 according to the volume of their different types of domestic needs. The types of expenditures identified were food, health, education (children, nieces/nephews and grandchildren), recreation and investment in the farm.

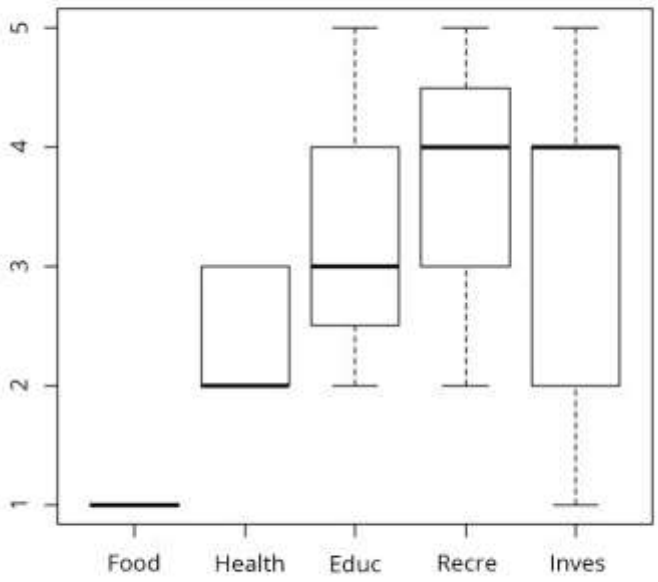

Figure 6. Distribution of pepper revenue by type of Naf household expenditure. Educ. – education. Recre. – recreation. Inves. – investment.

Our results indicated that the bulk of Naf pepper revenues are channelled into investment and recreation, while expenditures related to education are also significant when compared with those for health and food. The explanation for this behaviour is simple. Pepper revenues are obtained throughout the year and are highly dependent on successful sales. Consequently, households headed by men use revenues for recreation (e.g., parties, outings with friends). Food expenditures are lower because these households are also producers of food crops, vegetables, fruits, palm oil, livestock products, and other products that they then do not need to buy. Therefore, the results of investment expenditures are relatively higher for Naf households than for Aff households, and we believe that this refers to the medium enterprises belonging to VC1/Naf. It is important to note that within the scope of this paper, buying a simple pruning shear was considered an investment expenditure.

For VC2/Aff, the distribution of pepper revenues was similar to that of VC1/Naf, although investment and recreational activities tended to have higher representation. This finding seems natural because these farmers receive a one-time payment per year, allowing them to make decisions on more significant investments. Education means investment in children's schooling, which is positive but implies transportation costs due to the distance of farms from schools. Regarding health, Aff have a higher median than Naf, probably because Aff have more producers of older age than Naf (see Figure 3). Finally, food is less important for both Aff and Naf because they are both associated with subsistence farming.

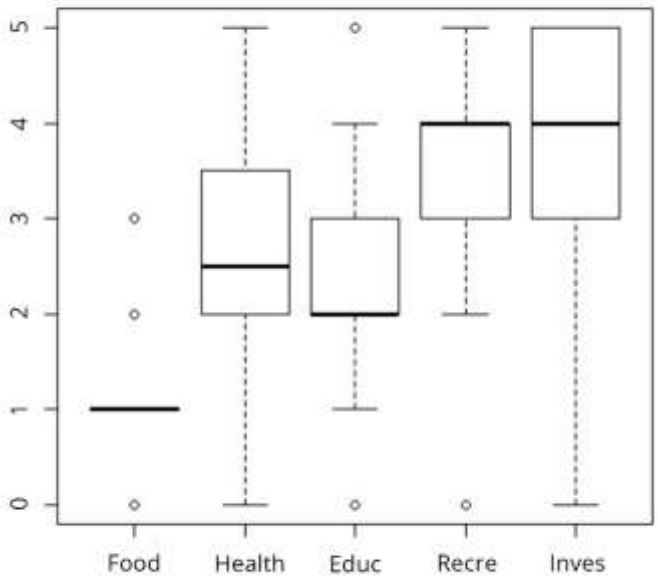

Figure 7. Distribution of pepper revenues by type of Aff household expenditure. Educ. – education. Recre. – recreation. Ines. – investment.

Net income for Aff and Naf

The income for Aff and Naf (Table 9) was the gross value because it did not include production and processing costs. The analysis used the average price for Naf because it is different among farmers and quite variable throughout the year (minimum = €4.90 and maximum = €12.20). For Aff, this is the price paid by the external buyer in 2017. The processing and production costs for Naf could not be determined due to the fragmentation of this sub-chain and the several production methods used by them. For Aff, the producers' price was around €2, which means a net income of €2487/ha (€2 × 1392.51 t/ha - €298.10). Thus, Aff net income is approximately 20% of gross income. Using this percentage for Naf, the net income is approximately €985 (0.2 × €6006.55 - 216.4). Our result shows that the income of certified organic farmers (Aff) was higher than that of farmers who are organic by default (Naf), which correlates with the outcome reported by Bolwig *et al.* (2009) in their studies related to the economics of smallholder organic contract farming in tropical Africa.

Table 9. Gross income per area for both Aff and Naf.

Type of producers	Equipment cost	Income \ha (€)	Prodt^{eq} (kg\ha)	Area^{eq} (ha)	Proti (year)	Slev (year)
Aff	298.1€	12532.59	1392.51	0.44	7.56	6.87
Naf	216.4€	6006.552	701.70	0.36	10.38	8.16

Note: Pepper price for Aff €9/kg, and average price for Naf €8.56/kg.

The main constraint between the difference in income of Aff and Naf is the illegal circuit of pepper from Aff to Naf when the Naf price is higher. This usually happens several months after the harvest season. This situation points to the necessity of a detailed study of all activities and production process costs in order to avoid potential losses and improve the efficiency of activities in the entire pepper sector.

Aff yields are almost double those of Naf. This outcome may be explained by the use of more advanced technical equipment and the permanent management of their plots among Aff, while Naf are organic only by default, exhibiting limited use of sustainable practices that can improve crop yield. There is a great deal of empirical evidence (Ann, 2012; Parvathi and Waibel, 2015) suggesting that the use of sustainable practices, such as the application of organic fertiliser, improves soil quality has a significant impact on crop yield. It is important to note that the productivity of pepper plants varies widely from region to region. For example, for conventional pepper, the yield varies between 3.1-2.9 t/ha of fresh pepper in Brazil, Mexico and India (Nelson and Cannon-Eger, 2011). For organic pepper in Malaysia, yields of 3.98 t/ha of dry pepper were reported by Ann (2012), while Parvathi and Waibel (2015) found 1.24 t/ha in India. In STP, climate conditions, such as the longer dry season and minimal organic solutions, namely, input supply and low-quality plot management, can have a negative impact on productivity, as described by Sivaraman *et al*., (1999).

Other income sources

Both groups of farmers studied have other income sources from cash crops, such as cocoa and coffee. Moreover, almost all of them have an additional source of income in off-farm activities (Figure 8). An extra source of income is important for improving smallholders' livelihoods when dealing with small and very small farming in a competitive market.

Regarding the extra income from agriculture (excluding pepper), Naf showed a higher percentage (>40%) than Aff (~30%). In contrast, Aff showed a higher percentage of revenues from off-farm activities (non-agricultural wages) than Naf. For two other sources (reform and wage/reform), the results are similar for Aff and Naf. Only a small proportion of Aff accumulated wages and retirement (approximately 10%).

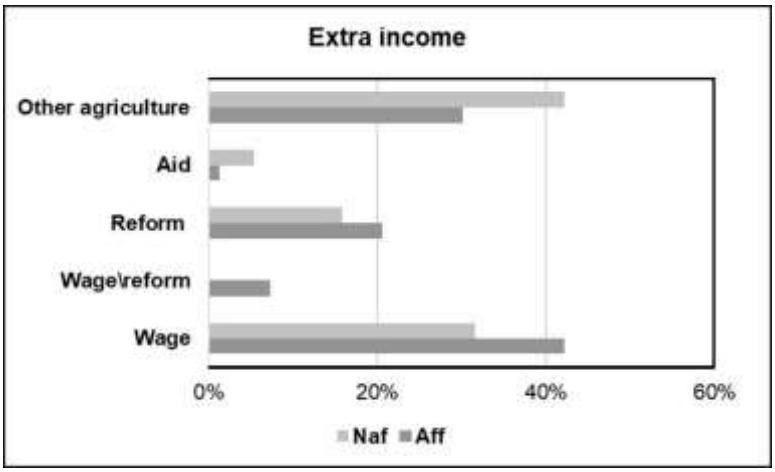

Figure 8. Additional source of income for Aff and Naf. Wage/reform are producers that still worked although they were retired.

Another main result is that smallholders in STP have more opportunities to develop off-farm activities (Figure 8), which is a positive outcome according to Oscar *et al*. (2015), and even the head-of-household can increase his/her income working off-farm.

Comparison between Aff and Naf using qualitative and quantitative variables

In terms of production systems, our findings suggest that there were similarities between these two sub-chains (VC1 and VC2), yet there were differences their agricultural practices. This outcome is because Aff farmers are associated with more professional practices, as they are involved in formal, consolidated circuits. As seen later in Tables 10 and 11, these groups do not differ greatly from each other in farmer characteristics.

Table 10. Analysis of qualitative variables based on Fisher's exact test for affiliated farmers (Aff) and non-affiliated farmers (Naf).

Type of producers		**Aff**			**Naf**		
Variables	**p-value**	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Owok	0.8	44	39	83	9	10	19
Phelp	0.04**	59	21	80	8	9	17
Ownc	0.28	24	59	83	8	11	19
Ref	0.25	25	52	77	3	15	18
Madd	0.0007***	66	5	71	6	6	12
Irr	052	20	37	57	5	6	11
Irrnew	1	34	25	59	6	5	11
Co.n	0.68	72	9	81	13	2	15
Agfai	0.74	22	61	83	4	9	13
Wokp	0.01***	77	6	83	13	6	19
Msour	0.06*	44	24	68	4	8	12
Syst	1	67	15	82	16	3	19

Note: Significant at * p<.1, ** p<.05, *** p<.01.

Concerning qualitative variables, only parents' help (Phelp), manure adding (Madd) and work plan (Wokp) showed significant differences at the 5% significance level. At the 10% significance level, manure source (Msour) was also significantly different between Aff and Naf. These variables showed significant differences because they are related to available workers, soil fertility (manure adding and its source) and farm management, which are important indicators to consider when the objective is to compare certified organic farmers and organic farmers by default. In a study about the economics of smallholder, organic contract farming in tropical Africa, Bolwig *et al.* (2009) concluded that the use of additional OA practices increased net revenue by 9% per additional practice.

Table 11. Quantitative variables treated based on Mann-Whitney (Wilcoxon rank-sum test for affiliated farmers (Aff) and non-affiliated farmers (Naf)).

Variable	p-value	Median	
		VC2/Aff, n=83	VC1/Naf, n=19
Prod	0.7922	300	350
Prodt	0.8347	600	750
Prodt^{eq}	0.1885	1100	750
Age	0.8327	55	56
Hhe	0.181	5	3.5
Numsu	0.3877	3	2
Area^{eq}	0.05965*	0.329	0.25
Area	0.1638	0.51	0.2
Cropn	0.09153*	666	500
Whour	0.2667	3	3
Wokn	0.2739	0	0
Proti	0.1104	7	16
Croag	0.07*	10	7
Slev	0.09253*	4	8

Note: Significant at * p<.1, ** p<.05, *** p<.01. (e) estimated, (eq) equivalent. The variables Prode and Prodte were estimated according to the model of production and productivity developed through data from Aff, presented above. Prodteq and Areaeq were calculated according to the area/plant for Aff (4 m^2) and Naf (5 m^2).

According to the results presented in Table 11, only Prodt^{e} (estimated yield) was significantly different between VC2/Aff and VC1/Naf. At the 10% level, the area^{eq}, Cropn, and Slev (equivalent area, number of plants and schooling years, respectively) were also significantly different between these two groups of farmers.

Area^{eq} was significant at the 10% level because more area means more work and more technical capacity, which is not accessible for smallholders. For Cropn, more plants in production equates to more pepper production. However, significance at only the 10% level suggests that producers could improve production per plant by applying practices to improve soil fertility and plantation maintenance. Regarding Slev, there is empirical evidence (Bingen et al., 2003; Karaan, 2006; Kansanga, 2017) suggesting that human capital relates to the productivity of farmers due to the acquisition of managerial and technical capacities, which is essential for enhancing agricultural productivities. Reimers and Klasen (2012) concluded, however, that the positive effect of education is small in poor countries and significant only in those where technology transfer can be rapid. The authors also pointed out that this positive effect is limited to the primary and secondary levels. Our results likely showed a significant difference at the 10% level because technology transfer is not easy, and the median number of years of education is approximately 4-8 years, which is not enough to reach, for example, the secondary level.

DISCUSSION

i. Pepper production system

The pepper culture in STP is being promoted through VC linked to the international market and with the strong support of external agents. A part of this chain remains informal, which be a threat, namely the competition between formal and informal sides.

As most of the farmers are smallholders, cooperative adoption was essential to get the necessary scale to satisfy the required demand from the external buyer. By the other hand, this cooperative face some weakness, such as the relationship between farmers and his staff and the farmers' understanding of the cooperative's role.

Among the three pepper production systems described in this paper's ambit, the most widespread is B neither for Aff and Naf. This system that means multicultural joins pepper with other crops, mainly commodities (e.g., cocoa and coffee), is one main specificity of African countries with an economy less diversified and dependent on old commodities.

Regarding the practices under the organic production system, Aff is better performed than Naf. However, more should be done, namely in pests and disease control, production and transport of cuttings, and soil protection. By applying sustainable practices and other activities to improve soil quality, VC2/Aff can enjoy the advantages of OA. In contrast, those in VC1/Naf are organic farmers by default; in other words, they do not apply chemical fertilisers but have little knowledge of other organic approaches, as described by Kleemann and Abdulai (2013). On the other hand, sustainable practices enhance resilience to climate change impacts (Scialabba and Muller-Lindenlauf, 2010), which is a serious challenge for all sectors of society.

Social analysis

Given the percentages of hired workers for both Aff and Naf (20-30%), local agriculture can be characterized as family farming. To highlight that these percentages in some cases may include temporary job.

Another challenge for pepper VC is to attract more young farmers that are vital for the success of cooperative. During the next decade, more than 75% of farmers in both groups will be above the retirement threshold.

Another point to stand up is percentages of women that are engaging in off-farm activities. This is important and should be promoted because can provide extra income, essential to improve livelihood.

In general, the roads are in bad conditions which is more harmful for Aff because they are inside the country. Roads are crucial infrastructure but, for countries with few resources and fragile economy this problem become more difficult to solve. Nevertheless, this data is important for policies design and negotiation with bilateral and multilateral donors.

Land tenure is an important question which concerns external investment. The land reform beyond the primary objective of providing food security also complied with guidelines followed by other African countries using their land reforms as instruments for farm development and investment described by Boone (2007).

Beyond the issues related to property rights, land security has a positive effect on agricultural production and farm management. In his studies about the dynamics of land security in agricultural production and environmental degradation in Africa, Bugri (2008) found that land security had a positive effect on agricultural production and the use of good environmental management practices.

Economic analysis

In general, farmers have other activities which is positive to provide extra income. In relation to the farmers full time, they have more than one culture and usually belong to more than one cooperative.

The revenues from pepper are applied in investment, school, and less in food expenses because most farmers practice subsistence agriculture.

Aff are more productive than Naf, and they also have more income than the last one. Moreover, the pepper price on the local market is very volatile, and sometimes it is harmful to the Aff. The yield of Aff can still be improved through new practices, irrigation, and control of diseases.

There is a concern that OA is less productive than conventional agriculture (Badgley *et al*., 2006; Reganold *et al*., 2016). For pepper, given its management requirements (namely, input supply), low yield can be compensated by the premium price paid to smallholders (Ann, 2012). However, when production systems and edaphoclimatic conditions are considered, promoting large-scale organic certification and maintaining the best market circuits seem to be viable strategies for small-scale farming in STP.

In short, these two groups are quite similar in their social conditions, but there are some differences in the qualitative and quantitative results obtained. The percentage of farmers working off-farm (approximately 30% of Naf and 45% of Aff) and the median years of education (4 for Aff and 8 for Naf) are some examples of these differences.

CONCLUSION

OA is advantageous and has been promoting livelihoods among converted smallholders in STP. However, the growth and adoption of new technologies and other OA practices are still required. The support of donors is at the core of this process and should be reinforced in areas such as infrastructure, training and services.

The performance of Aff is better than that of Naf in terms of OA approaches, technologies and especially yields, which were double those of Naf.

Organizing these producers in cooperative was vital for the success of this VC because the scale remains one of the major problems of small farming. Moreover, building the cooperative should be replaced by promoting support services such as extension, company for microcredit, and input supply.

Developing countries continue to face difficulties in applying standards, and one way to solve this problem is to design policies for economic regions. The fragmentation is blocking the development of African agribusiness, and it is one challenge that groups of countries can try to solve together.

In short, a robust agricultural sector, even supported in small farming, need technologies and innovation. In this paper, the technology was discussed, and it is at a low level as it happens around the developing world. That is why to mitigate this gap from developed countries more external investment should be attracted.

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