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**ORCID**
IP: 0000-0001-6833-5155
MRL: 0000-0002-5731-767X
AM-C: 0000-0001-9247-9167
PDH: 0000-0002-9646-3223

# Organic cocoa farmer's strategies and sustainability

Ibrahim Prazeres[1,*], Maria Raquel Lucas[1], Ana Marta-Costa[2], Pedro Damião Henriques[3]

[1] *CEFAGE - Center for Advanced Studies in Management and Economics, Portugal*
[2] *CETRAD - Centre for Transdisciplinary Development Studies, Portugal*
[3] *MED - Mediterranean Institute for Agriculture, Environment and Development, Portugal*
*Corresponding author. E-mail: gibaedy@gmail.com

**Abstract.** São Tomé and Príncipe (STP) is one of the world's smallest organic cocoa exporting countries, whose product has a positive socio-cultural and economic impact. Small producers who ensure it, are associated into two cooperatives that experience several difficulties and dilemmas including climate changes and poverty. Diversification of livelihood strategies could lead to wellbeing, poverty and climate mitigation. The aim of this study was to analyse producers' perception of sustainability related to the organic cocoa production in STP and to explain the influence of different factors on their livelihood strategies (LS). An ordered probit model for disaggregation of factor categories was used for the 2021 period. The results showed that gender, age, family size, members on-farm and off-farm work and professional training courses do not influence livelihood strategies. The important variables for them are education level, perception of social class, insurances and loans and access to services.

**Keywords:** households decisions, crop diversity, dependence, ordered probit model, well-being.
**JEL Codes:** Q12, Q56, O13.

## 1. INTRODUCTION

There is an overall consensus about the sensitivity of agriculture to climate neutrality (Tol, 2018; Piedra-Bonilla *et al*., 2020) and the importance of sustainability to achieve its goals and ~~to~~ meet consumer expectations and farms' profits (Menozzi *et al*., 2015).

However, while the environmental and economic dimensions of sustainability have been theorized more robustly (Hovardas, 2021; Purvis *et al*., 2019), the social dimension, which is context-specific and inherently subjective (Boyer *et al*., 2016), has lacked comprehensive approaches, notably in rural areas (Gaviglio *et al*., 2016). According to Rasmussen *et al*. (2017), only 25% of the scientific articles dedicated to sustainability in agricultural production consider the social dimension, and the most used indicators in this

field are related to the farm labour, quality of life and well-being, and the relationship with the human community (Marta-Costa *et al*., 2022).

The lack of an approach to social sustainability in studies on developing countries, where poverty is the most serious problem, could compromise the performance of the two others pillars (Prazeres *et al*., 2022a), since the relationships among the three dimensions is generally assumed to be compatible and mutually supportive (Boström, 2012; Chopin *et al*., 2021).

There are several studies in the literature that reveal the problems and challenges faced by smallholder farmers affecting the production system. These problems come as a result of isolation, small farm size, low levels of technology, innovation and productivity due to farming systems under traditional practices (Prazeres *et al*., 2021; Díaz-Montenegro *et al*., 2018), climate changes (Piedra-Bonilla *et al*., 2020) and a failure to attract young people and ensure farm succession and/or rejuvenation (Anyidoho *et al*., 2012; Henning *et al*., 2022). Additionally, these farmers are constrained by limited financial, natural, health and educational resources, scarce governance and/or organisational support, and pressure to use land with alternative crops or activities, which are more profitable (Prazeres & Lucas, 2020; Prazeres *et al*., 2021). Additionally, they must adapt to severe crop losses due to disease and, very often, they need to consider other activities when making the choices on their livelihood strategies (Tittonell, 2014; Valbuena *et al*., 2015; Walelign, 2016; Walelign & Jiao, 2017). Thus, the sustainability social pillar makes the search for livelihoods a priority in order to reduce poverty and increase the farms' wellbeing.

In São Tomé and Principe (STP), agriculture comprises a third of the active population and cocoa activity contributes to over 90% of the national exports, standing out from other export products such as coffee, coconut, flowers, pepper and other spices. In addition to the high amount of cocoa as exported goods (Signoret, 2019) and its contribution to the GDP (21%), organic cocoa production (OCP) leads the international country image and guarantees the livelihood of many poor families, by creating jobs and developing local economies (Prazeres, 2019). Approximately three thousand and three hundred organic small producers are integrated into the existing two cooperatives (CECAB and CECAC11). There are also organic private companies with their own production, from which Satocao and Diogo Vaz are the most relevant, the latter having its own chocolate factory and shops (Prazeres, 2019).

The sustainability of OCP in STP matters considering its impact on the agro-ecological system, the social and environmental context of the producing communities, the economic viability of the activity, and the farmer wellbeing, as well as, the viability of the consumer market, which directly relates to consumer trust in the OCP and consecutive willingness to pay a premium for such (Prazeres, 2019).

This paper attempted to explore the nexus between livelihood strategies and sustainability perception, households' organic cocoa dependency, and poverty. The livelihood strategies formed the basis for categorising producers based on households' structure and crop diversification.

The paper was organised into five sections. The following section presents background information on sustainability, poverty and livelihood strategies. The third section describes the empirical strategy and econometric specification, while the fourth section exposes and discusses the findings. The final section is dedicated to the conclusions and policy and its practical implications.

## 2. BACKGROUND

Sustainable development has become a global pursuit to the agricultural sector due to increasing greenhouse gas emissions and depletion of natural resources needed for agricultural activities (Bekun *et al*., 2019; Sarkodie & Strezov, 2019; Food and Agriculture Organisation [FAO], 2014). These challenges are furthered by the social and economic pressures that arise in a globally competitive environment (Iocola *et al*., 2018; Ramos, 2019; Santos *et al*., 2019; Vasileiou & Morris, 2006; Velten *et al*., 2015), such as rising input prices, labour supply instability, relationships with the end-product market and food safety concerns, which further evidence the need to implement sustainable practices (Christ & Burritt, 2013).

Elkington (1994)'s Triple Bottom Line theory is often regarded as the most well-known and comprehensive theoretical model used in the sustainable development approach (Hayati, 2017). This theory argues that People, Planet and Profit are imperative principles of sustainability and promotes the idea that sustainable development occurs when organisations demonstrate responsibility towards environmental health, social equity and economic viability (Hayati, 2017; Iyer & Reczek, 2017).

The geographic context takes particular importance in the sustainability paradigm, for which locally configured institutional and biophysical processes shape the criteria and scope of the analyses. Therefore, livelihood strategies need to be seen in light of the extent of the resources' constraints and their availability, which

support communities in achieving livelihood objectives (Chilombo & van der Horst, 2021). For instance, the poverty evidenced in rural areas of low- and middle-income countries, that hinders individual and community capacities to meet basic needs, stands out as a multidimensional global challenge to sustainable development (Alemie *et al*., 2022). In these areas, about 90% of the people depend on agriculture for their livelihoods (FAO, 2005; IFAD, 2011; Roser, 2015; Mphande, 2016 in Alemie *et al*., 2022), making it urgent to seek strategies that promote the sustainability of agroecological systems and support improvements in the social and environmental context of producing communities (Prazeres *et al*., 2019).

The concept of sustainable livelihood appeared in the 1980s (Chambers & Conway, 1991), ~~and~~ remerged in Chilombo and Van der Horst (2021) and has become a classic paradigm for the study of household livelihoods (Kuang *et al*., 2020). It is focused on coping strategies intertwined with livelihood activities that are linked to the exploitation of land-based resources in rural communities (Kuang *et al*., 2020).

Several studies have been conducted on the livelihood strategies that affect the interaction of sustainable dimensions, specifically in the African context and the agricultural sector. Alemie *et al*. (2022) identified complex interdependencies between livelihoods and the regulatory supply and cultural ecosystem services, which create bottlenecks to effectively 'block' poverty in Ethiopia, where 85% of the population are subsistence farmers dependent on local ecosystem services.

The research by Berhanu *et al*. (2022) found that an asset-based social policy improves the well-being of poor and vulnerable subgroups and Chilombo and van der Horst (2021) define assets in terms of human, natural, physical, social and financial capital and capabilities.

The capital assets in conjunction with the activity variables and the outcomes, constitute the three closely connected components in which several studies focused on smallholder farmers are concentrated (Ellis, 2000; Winters *et al*., 2009; Nielsen *et al*., 2013; Walelign & Jiao, 2017). Empowerment and community involvement play an important role in this context (Arroyo, 2013).

The achieved livelihood strategies' outcomes increase income, multidimensional wellbeing and a more sustainable use of natural resources (Babulo *et al*., 2008).

However, no single livelihood strategy provided both optimal economic advantages and ecological sustainability (Ghazale *et al*., 2022). Even when the households' choices induced similar livelihood activities, the time or capital used on the diverse livelihood activities may be different (Walelign & Jiao, 2017).

Still in this sustainable perspective, Deng *et al*. (2020) forward three determinants of livelihood sustainability – livelihood basis, livelihood acceleration and livelihood environment linked with "starting force", "driving force" and "supporting force," respectively, which support different levels of livelihood performance and dynamic processes of livelihood sustainability.

The livelihood strategies are changing over time (Walelign *et al*., 2017) originating the livelihood transition or mobility (Zhang *et al*., 2019). According to Zhang *et al*. (2019), the assessment of the factors that affect this transition has strong implications on poverty reducing policies and achieving livelihood sustainability in the long run.

Since livelihood is composed and conditioned by many factors, including ecology, economy, society and institution (Zhao, 2017), sustainable livelihood development is affected by the combined action of many elements (Deng *et al*., 2020).

The farmers' decisions on agricultural production that are based on the livelihood assets, also support families in coping with livelihood vulnerability and risks (Fang *et al*., 2014; Liu *et al*., 2018; Jalón *et al*., 2018; and Kuang *et al*., 2020).

In order to deal with natural threats and market risks, farmers try to adjust crop diversity, water and fertiliser management as well as agricultural financial and agrotechnical support (Kuang *et al*., 2020).

## 3. METHODS

Seemingly, cocoa production connects smallholder farmers and their families or representatives in producer countries, to a global value chain and markets, driven by a strong, consistent and increasing demand for chocolate. The global chocolate market size was estimated at USD 113,16 billion in 2021 and is anticipated to grow at a compound annual growth rate (CAGR) of 3,7% from 2022 to 2030 (GVR, 2021). The main characteristics of this worldwide value chain are the asymmetric power relations with increasing control by a few (5) corporations which make the big decisions (Diaz-Montenegro *et al*., 2018). In reality, there is a great geographic distance between highly atomized producers and the consumption markets, and cocoa producers are ignorant on consumer's preferences and their choices (Prazeres, 2019). Additionally, there is price volatility and dependency, albeit no solid connection, on five big companies which control the market and the cocoa supply worldwide. Consequently, an asymmetric distribution of value occurs, with cocoa producers receiving only 5%

of the price paid by the final consumer, while marketing and industry activities seize 25% and sales of retail chocolate capture 70% of the profits (Fountain & Huetz-Adams, 2020; Squicciarini & Swinnen, 2016; Abdulsamad *et al*., 2015). This situation is responsible for several of the problems and challenges faced by producers, one of which is poverty. Livelihood strategies are responses to farmer's decisions to face these problems, which are influenced by several factors, such as crop diversification, resources allocation (Rahman, 2016), climate changes (Rahman, 2016; Mu *et al*., 2018), soil fertility, biodiversity loss, real estate pressure through land use (Prazeres, 2019), and trust on farmers' organisations and their bargaining power (Prazeres *et al*., 2021).

In STP, where agriculture comprises a third of the active population, there are two models of cocoa production: conventional with a total yield production of 2,488 tons in 2017, which is very dependent on the prices of the New York Stock Exchange, and the certified production method (total yield production of 1,065 tons in 2017) as organic or organic plus fair trade (EU, 2021). It is expected that external economic factors, such as market prices and support as well as internal factors such as physical, social, human or natural capital, could influence producer's decisions to choose cocoa or other crops. Prazeres *et al*. (2022b) identified three livelihood strategies of OCP in STP (organic cocoa mono-crop livelihood strategy, diversified livelihood strategy with two crops - organic cocoa and banana or other and, pluriactivity livelihood strategy combining organic cocoa with three or more crops). These livelihood strategies are mainly related to the allocation of capital assets and income variables. Families with a low proportion of allocated land had higher income diversification strategies and vice versa. The study also showed that understanding how cocoa producers seek different approaches, could help envisage livelihood strategies as a way of increasing income and producers' wellbeing, as well as alleviate poverty. Also, increases in livelihood can be used by producers for consumption, commercialization or conversion into livelihood assets (Zhang *et al*., 2022).

### *3.1 Statistical model*

The diversity of livelihood strategies can be compared and the effect of different categories of factor variation can be found without the problem of selection bias. Hence, the causal relationship among those factors will be controlled following general models presented in the literature (Dusen *et al*., 2005; Benin *et al*., 2004; Piedra-Bonilla *et al*., 2020), in which livelihood strategies election is affected by factors that could be gathered as social, economic and agroecological. Thus, an ordered probit model was estimated in which the variable to be studied was the livelihood strategies, measured on a scale of three points (*LS1=Mono-crop, LS2=Bi-crop, LS3=Multi-crop*). This model can be represented as follows:

$$\begin{aligned} &LS_i^* = x_i'\beta + \varepsilon_i,\ \varepsilon_i \sim \text{NID}(0,1) \\ &LS_i = 1 \text{ if } LS_i^* \leq \gamma_1 \\ &LS_i = 2 \text{ if } \gamma_1 < LS_i^* \leq \gamma_2 \\ &LS_i = 3 \text{ if } LS_i^* \geq \gamma^2 \end{aligned} \quad (1)$$

in which $LS_i$ represented the livelihood strategy $i$ and, $\gamma_1$ e $\gamma_2$ were parameters to be estimated in conjunction with $\beta$. The estimation of the model was based on the maximum probability of occurrence and the interpretation of the coefficient was done in terms of the latent variable or in terms of the effects on the respective probability. For example, $\beta_j > 0$ meant that the latent variable $LS^*_1$ increase if $x_{ij}$ increases.

Thus, the probability of *LS3* (*Multi-crop*) increased while the probability of *LS1*(*Mono-crop*) decreased. The effect on the intermediate category was however ambiguous as it $P\ (LS_i=2 \mid x_i)$ could increase or decrease.

### *3.2 Data collection*

A survey was conducted from June to December 2021 on a sample set of 810 farmers involved in the OCP in STP through cooperatives. The selection criteria were both, the cooperative proposals and the availability of the producer to cooperate with the research. Compliance with the General Data Protection Regulation was assured throughout. The participants were informed about the use of the information, their rights, and their responses were anonymized.

All of the contacted OCP producers were members of one of the two cooperatives (CECAB created in 2004, operational from 2005 and autonomous since 2012, and CECAC11 created in 2011), which represent the main interface between farmers and the chocolate industry or their representatives or signed a contract with one of the two private companies. Both cooperatives are funded by the Fund for the Development of Agriculture (IFAD) and the Project to Support Commercial Agriculture (PAPAC) and they are supported by various non-governmental organizations as well as the Center for Agricultural and Technological Research (CIAT). Each of the cooperatives brings together different associations organized by geographic zones, which receive the cocoa seed from farmers on two distinct periods (August-September

and February-March). The training of the farmers and motivation strategies to guarantee the levels and quality of organic cocoa production are carried out by the cooperatives, which also train technicians from the associations that form them and to which the producers belong, these technicians, in turn, then train the farmers. An important role is played by the so-called "sociotechnicians", who are producers with good performance in the cocoa culture and who monitor other farmers and are remunerated for this task. In reality, these socio-technicians end up replacing the role of the extension services that the state was responsible for ensuring. In addition to strictly agricultural work, the cooperatives develop other actions, such as socio-recreational activities in the communities, inviting specialists who contribute to raising awareness among farmers on various topics (domestic violence, gender equality, alcohol consumption, diseases), financing small social works in the communities and providing support to the neediest (medicines, eyeglasses, coffins). The registration of all information is done manually at the level of the associations and the computerization is done by each cooperative.

The study area included the most significant OCP districts and rural communities in STP, namely all the districts in the country, with the exception of Caué, Pagué and Santo António – districts in the Principe Island – because they were not OCP certified members of the cooperatives. As shown in Figure 1, the survey was conducted in different steps, starting with 25 preliminary qualitative interviews with 4 cooperatives representatives and other stakeholders (4 distributors and/or exporters, 2 certification bodies, 3 private companies, 5 sociotechnicians, 2 researchers, 4 government agencies) and the establishment of 10 focus groups of 20 participants (farmers), so to specifically capture the individual and collective perception of the sustainability concept and its main drivers and challenges.

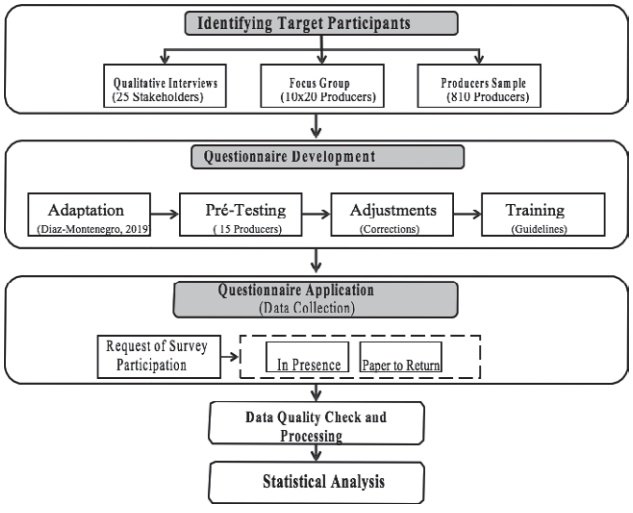


**Figure 1.** Analysis design.

Then, a questionnaire based on the livelihoods adapted from Diaz-Montenegro (2019) was applied to the organic cocoa producers, structured in three main sections. The first was dedicated to the characterisation of the household and the farm and incorporated five topics related to: Human capital (16 questions on the characterisation of the family and its relation to the farm), Natural capital (16 questions on used land and produced crops ), Physical capital (4 groups of questions about machinery, equipment and support infrastructures), Financial capital (6 questions about financing sources), and Social capital (12 questions on partnerships and cooperation and enjoyed benefits);. The second session was devoted to ~~2)~~ Risk perception and attitude and considered the probability of occurrence, their impact severity and degree of control of 19 events identified from both the literature and the country context. This group also included two questions dedicated to the management and tool preferences for risk management, comprising 12 options taken from the literature and the analysis context, and an open question where other options could be considered, namely for the future. The perceive value of joining an OCP cooperative was considered as the last section by including 12 options for assessing the benefit and cost of working with the cooperative. The reduced version of the PERVAL scale (Walsh, Shiu & Hassan, 2014) was explored in this context. This reduced version included 12 items (either observed or manifested variables or indicators, structured from ordinal variables with 7 Likert-type response categories, in which 1 meant the highest degree of disagreement and 7 the highest degree of agreement) related to four constructs (or dimensions, latent variables or factors) that underlie the abstract and multidimensional concept of Value: Functional Value, Emotional Value, Social Value and Monetary Value.

In the beginning of the questionnaire, a request of participation was highlighted alongside an explanation of the study's purpose and the guidelines to fulfil the questionnaire, so to prepare and commit the participants to the survey. Participants could fill the questionnaire in two ways: direct interview in person or through a paper questionnaire due to return and collect two days after. A total of 838 questionnaires were completed, 180 by paper and the remaining face-to-face. After the removal of 28 incomplete questionnaires, the final sample consisted of 810 respondents.

*3.3 Sample Characteristics*

Figure 2 summarises some of the statistics of surveyed smallholders, by livelihood strategies. Table A1, in appendix, presents the description of all the characteristics of the sample set, which was almost equally distributed between the two cooperatives.

Most of the participants of the sample were male, while 33% of the farmers were females and 52,2% belonged to CECAB. The livelihood strategies identified were differentiated by the number and proportion of farmers engaged in growing organic cocoa (with or without other crop combinations), and their ways of allocating resources (14,2% concerned the proportion of farmers who engaged solely in organic cocoa growing, in mono-crop livelihood strategy LS1, 63,5% were involved in a diversified livelihood strategy (LS2) with two crops (organic cocoa and banana), and, 22,2% were engaged in a multi-crop livelihood strategy (LS3), which were combined three or more crops and livelihood activities. The OCP area for the sample was on average 1,95 hectares, with the highest surface value of 12,5 hectares and the lowest value of 0,5 hectares. The average household size varied from 3,6 members in mono-crop to 4,8 in multi-crop and 4,2 in bi-crop livelihood strategies.

## 4. RESULTS AND DISCUSSION

The estimation of equation (1) using an ordered probit model yielded the results shown in Table 1. The statistical results related the dependent variable livelihood strategy (*LS1=Mono-crop, LS2=Bi-crop, LS3=Multi-crop*) with the explanatory variables . The explanatory variables were grouped in human, financial and economic, natural, physical and social capital as well as in risk perception and management and perceived value.

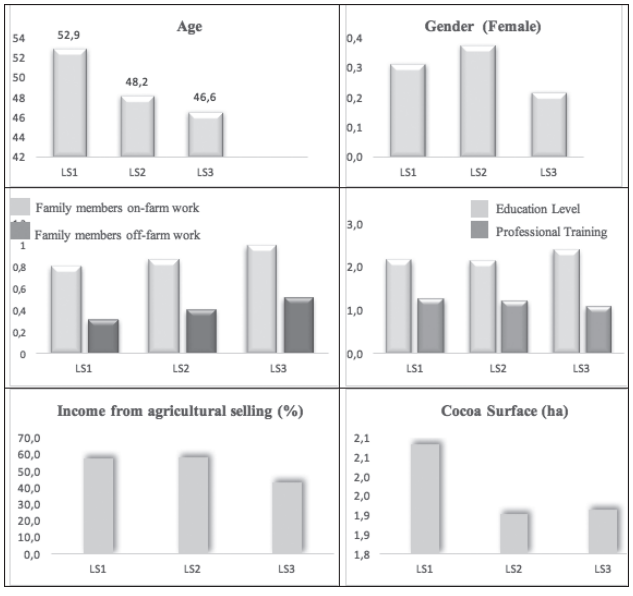


**Figure 2.** Summary of characteristics of the respondents.

Regarding human capital explanatory variables, the level of education and perception of social classes influence the livelihood strategies. Farmers of the mono-crop strategy have higher level of education than multi-crop farmers. In fact, the greater the level of education, the lower the probability of belonging to multi-crops and the greater the probability of belonging mono-crop strategy. As other studies sustained (Balogh, 2021, Reimers and Klasen, 2011; Hernández-Núñez et l., 2022), probably this is because a higher level of education leads to decisions involving greater productive efficiency, being mono-crop suitable for these choices because it is more efficient than multi-crop. In the specific STP context, Sequeira et al. (2022) concluded that improvements into production systems lead to increased family income and help to cross poverty line.

In contrast to education level, the livelihood strategy has a positive relation to social class perception. Farmers of the multi-crop strategy have a perception of belonging to higher social class than farmers of the mono-crop strategy.

This does not seem compatible with the study of Irfany et al. (2020) where social class does not influence livelihood strategies. However, the result obtained could be related to the fact that an increased social class perception allows for a belief of being under better economic conditions which is in turn beneficial to the production of organic cocoa in multi-crop (LS3).

Although not significant, there is a higher probability for mono-crop strategy to have female and younger farmers and a lower number of on-farm family members while family size, professional training courses and number of off-farm family members are higher for multi-crop livelihood strategy. Despite OCP being the main activity in the three LS, farmers also engage in different income generating activities, such as off-farm employment. The explanation for that could be related to the fact that which enables them to build better assets, increase economic sustainability and could start becoming integrated production systems (Gebru et al., 2018). Additionally, off-farm self-employment is one of the variables that significantly improves welfare but has lower probability of existing in mono-crop (Irfany et al., 2020). However, in the existing results concerning off-farm the employment, the greater the number of off-farm work members, the greater the probability of selected

**Table 1.** Results of the Probit model for livelihood strategies.

| | Coefficient | Standard error | z | p-value |
|---|---|---|---|---|
| *Human Capital* | | | | |
| Gender (F) | -0,236 | 0,184 | -1,286 | 0,198 |
| Age | -0,007 | 0,007 | -1,106 | 0,269 |
| Family size | 0,054 | 0,045 | 1,201 | 0,230 |
| Education level (EL) | -0,616 | 0,179 | -3,447 | 0,001*** |
| Number of professional training courses | 0,026 | 0,125 | 0,206 | 0,837 |
| Members on-farm work | -0,026 | 0,117 | -0,224 | 0,823 |
| Members off-farm work | 0,228 | 0,147 | 1,549 | 0,121 |
| Perception of social class (SC) | 0,674 | 0,130 | 5,182 | <0,0001**** |
| *Financial and Economic Capital* | | | | |
| Income from agricultural selling | 0,007 | 0,004 | 1,600 | 0,110 |
| Income from subsidies (human development and others) and remittances from emigrants | -0,082 | 0,360 | -0,229 | 0,819 |
| Insurances and loans (IL) | 0,929 | 0,239 | 3,891 | <0,0001**** |
| *Natural Capital* | | | | |
| Cocoa area | 0,266 | 0,212 | 1,256 | 0,209 |
| Cocoa production | 0,000 | 0,000 | -0,280 | 0,779 |
| Banana area | -0,200 | 0,195 | -1,026 | 0,305 |
| Banana production | 0,000 | 0,000 | 1,629 | 0,103 |
| *Physical Capital* | | | | |
| Access to potable water | -0,346 | 0,189 | -1,824 | 0,068* |
| Access to electricity | -0,217 | 0,561 | -0,387 | 0,699 |
| Access to harvest storage (HS) | 1,708 | 0,651 | 2,621 | 0,009*** |
| Access to transportation | -0,732 | 0,373 | -1,960 | 0,050** |
| Access to roads | -0,292 | 0,187 | -1,555 | 0,120 |
| Access to landline | 0,316 | 0,399 | 0,792 | 0,428 |
| Access to mobile phone (MF) | 1,791 | 0,396 | 4,520 | <0,0001*** |
| Access to internet | 0,470 | 0,207 | 2,272 | 0,023** |
| Access to TV and radio | 0,694 | 0,380 | 1,825 | 0,068* |
| Access to health center HC) | -2,426 | 0,548 | -4,428 | <0,0001*** |
| Access to schools | -0,445 | 0,258 | -1,723 | 0,085* |
| Access to extension services (ES) | -0,895 | 0,291 | -3,077 | 0,002*** |
| *Social Capital* | | | | |
| Belong to CECAB | -0,490 | 0,217 | -2,260 | 0,024** |
| Satisfaction with cooperatives | 0,530 | 0,248 | 2,131 | 0,033** |
| Trust level in neighbours | 0,033 | 0,125 | 0,261 | 0,794 |
| Trust level in civil organizations | 0,119 | 0,148 | 0,804 | 0,421 |
| Trust level in agricultural organizations | -0,031 | 0,101 | -0,312 | 0,755 |
| Trust level in district council | -0,797 | 0,622 | -1,280 | 0,201 |
| Trust level in local council | 1,243 | 0,614 | 2,024 | 0,043** |
| Trust level in cooperatives (TC) | -0,875 | 0,243 | -3,603 | 0,000*** |
| Trust level in government | -0,240 | 0,259 | -0,929 | 0,353 |
| *Risk Perception and Management* | | | | |
| Perception of the likelihood of risks occurring (LR) | 0,499 | 0,161 | 3,094 | 0,002*** |
| Perception of risk impact severity | -0,507 | 0,221 | -2,297 | 0,022** |
| Perception of the degree of self-control of the impact | -0,084 | 0,259 | -0,323 | 0,747 |
| Perception of the importance of risk management tools | -0,165 | 0,140 | -1,181 | 0,238 |

| | Coefficient | Standard error | z | p-value |
|---|---|---|---|---|
| *Perceived Value Scale (PERVAL)* | | | | |
| Perception of the Functional value to joining a cooperative (CFV) | -0,589 | 0,189 | -3,109 | 0,002*** |
| Perception of the Emotional Value joining a cooperative (CEV) | 0,481 | 0,180 | 2,667 | 0,008*** |
| Perception of a social value joining a cooperative (CSV) | 0,702 | 0,253 | 2,773 | 0,006*** |
| Perception of a monetary value joining a cooperative (CMV) | 0,271 | 0,243 | 1,114 | 0,265 |
| e | | | | |
| Log. of likelihood = −249.071 | | | | |
| Likelihood ratio test: Chi-square (44) = 286,245 [0,0000] | | | | |

(*), (**) and (***) significant at 10%, 5% and 1%, respectively.

LS3 (multi-crop) and the lower the probability of having LS1 (mono-crop). In the case of on-farm work, the greater the number of on-farm work members, the lower probability of selected LS3 (polyculture) and greater the probability of having LS1 (mono-crop). This is because mono-crop depend mainly on familiar work than external work. Despite external work income being a significant source of income (Bjornlund et al. 2019; Pritchard et al. 2019), it is associated with greater risks and thus, has a negative impact on the well-being of households (Nielsen et al. 2013; Bjornlund et al. 2019).

Concerning economic and financial capital, the results obtained for insurances and loans show that the probability of multi-crop livelihood strategies having insurance and loans is higher than de mono-crop strategies as well as the proportion of income from agricultural sources. In general terms, these results are compatible with those found in Irfany et al. (2020)'s study, which displayed that cocoa producers, predominantly males, depended on loans, despite the fact that only a few have accessed formal loans. To Ankrah et al. (2023), reducing loan interest rates can foster financial inclusion. In STP, loan interest rates are very high and the OCP have difficulty to access formal banks. This is very important because other significant determinants of livelihood practices were, for instance, access to formal credit for self-employment, among others. Also Kuang et al. (2020) exposed that farmers' social, financial and human assets can mitigate their livelihood risks in agricultural production, while their social, natural and physical assets have positive effects on the adoption of the strategies. However, natural and physical assets have the opposite effects in livelihood risks such as the human and financial assets have relatively weak influences in the adaptation strategies (Kuang et al., 2020).

The livelihood strategies are not related with natural capital explanatory variables, namely, area and production of cocoa and banana. These results were also in line with those found in Andres *et al.* (2016), particularly when dynamic agroforestry systems are introduced on a small scale. For the authors, through mimicking natural forests, these systems offer multiple benefits such as soil fertility enhancement, reduction of pests and disease pressure, erosion control, and revenue diversification. Very often, the diversification is induced by income-generating activities to smooth income, accumulate wealth and reduce exposure to risk (Sun et al., 2019).

Physical capital explanatory variables show in a clear way that access to potable water, transportation, health centers, schools and extension services are higher for mono-crop farmers than for multi-crop farmers while access to harvest storage, mobile phone, internet and TV and radio are higher for multi-crop farmers. It is clear that mono-crop farms have better access to state-dependent infrastructures, possibly due to the location of agricultural enterprises, while multi-crop farms have better access to services that depend on individual decisions and consumption. According Pereira et al. (2022), development programs implemented in STP to improve infrastructure and agricultural production, made a positive contribution to the well-being of rural households. Similar results found Trigueiros et al (2022) emphasizing the importance of this investments programs to improve socio-economic development and households sustainability. The perception of the importance of this public policies are more valued by male than female (Pereira et al, 2022).

Regarding risk perception and management of events that affect agricultural production and family income, the results show that livelihood strategies are different for the perception of events occurring, being this perception higher for multi-crop than for mono-crop farmers and, for severity of events, the mono-crop livelihood strategy have higher severity perception than multi-crop farmers. Thereby, adverse events are less perceived by mono-crop which value more the severity of

impact. It should mention, specifically in STP insular context where climate changes consequences are become severe, that public policies are essential tools to mitigate risk events and impacts (Gomes, 2021).

Concerning the four dimensions of the perceived value of joining a cooperative, the emotional (CEV) and the social values (CSV) of joining a cooperative, the greater the perceived value, the greater the probability of electing LS3 (multi-crop) and the lower the probability of having LS1 (mono-crop). In the case of the functional value the opposite is observed. From a production stand point, similarly to the results obtained by Moreno-Miranda et al. (2020) in–Ecuador, the price paid for product certification is debatable and not perceived as valuable.

On the linkage between livelihood strategy and the sustainability at farm level, in addition to the difference between mono-crop vs. multi-crop, it was possible to add other elements. The economic dimension of sustainability, measured by land area and number of income sources, revealed that bi-crop and multi-crop have similar areas (3,7 ha) but greater than mono-crop (2,1 ha) while the number of sources of income are higher for multi-crop (4,2) than for mono and bi-crop (2,2). Globally, multi-crop exhibited higher economic sustainability than mono and bi-crop livelihood strategies.

The social dimension of sustainability measured by the number of basic services accessed, number of professional training courses and level of trust in institutions, displayed that: mono (8,8) and bi-crop (8,4) have greater access to a higher number of basic services than multi-crop (6,7); the number of professional training courses were decreasing from mono (1,3) and bi (1,2) to multi-crop (1,1); and the level of trust in institutions was also decreasing from mono (2,6) and bi (2,5) to multi-crop (2,3). Overall the mono-crop–livelihood strategy was more robust in terms of social sustainability.

Finally, the environmental dimension of sustainability, measured by the number of crops and productivity levels, disclosed that: as expected multi-crop (3,6) has an average number of crops higher than bi-crop (2) and mono-crop (1) strategies; and Cocoa productivity for multi-crop (706 Kg/ha) is higher than bi-crop (614 Kg/ha) and mono-crop (479 Kg/ha) while banana productivity for multi-crop (918 Kg/ha) is higher than bi-crop (435 Kg/ha). Thus, the multi-crop livelihood strategy is; more environmentally sustainable than mono and bi-crop livelihood strategies.

As a whole multi-crop is the most sustainable livelihood system. There is acceptance that certified OCP have a positive sustainability effect (Blockeel et al, 2023) as well as crop diversity, as a result of increasing sources of food and income, reducing the risk of adverse events and their impact and having a positive effect on biodiversity.

## 5. CONCLUSIONS

Organic cocoa production is one of the most valued crops in STP and world-wide. The country follows ancient ancestral-style production practices, in which most of the production is in the hands of small-scale producers primarily associated with two cooperatives, which face significant obstacles regarding their sustainability.

Small scale cocoa production in STP is organized in different livelihood strategies, mono, bi e multi-crop that have similarities and differences among them and represent distinctive production systems. These three strategies have been developed as means of survival of rural households, with dependency of organic cocoa production and, in many cases, incomes still below the poverty line. This is due to the low level of production obtained, which does not allow a better position in the market, and the poor access to technical support.

Rural cocoa households have been sustained by cocoa cooperatives governance and sociotechicians' support. Cooperative goals are toward inducing and advising farmers to avoid mono-crop in order to achieve greater (bio)diversity and ecosystem services, wellbeing and economic access. These provide enhanced levels of sustainability, climate neutrality transition and market shock prevention which are expected to increase in frequency and intensity.

This research shows that globally, multi-crop livelihood strategy have the highest economic sustainability, mono-crop livelihood system was more robust in terms of social sustainability and multi-crop livelihood strategy was the most environmentally sustainable. Thus, as a whole, the multi-crop livelihood strategy is the most sustainable livelihood system.

The bi-crop and multi-crop livelihood strategies, have the potential to offset environmental and economic risks and consequently improve sustainability and wellbeing. Such pathway is relevant for a country like STP which depends economically on its OCP in order to maximize short-term productivity and profitability. Nonetheless, cocoa mono-crop has been associated with soil erosion and degradation, biodiversity loss, as well as increased susceptibility to climate change impacts, pests and diseases.

The multi-crop livelihood system is the more resilient strategy, because it holds diversified sources of

income and seems more realistic in terms of management, strategies and in the face of risks. Nonetheless, it is less autonomous because it further depends on outside linkages (e.g. off farm labour and cooperatives support).

Mono-crop farmers are more autonomous because they hold higher levels of education and experience, as well as greater access to technical support, therefore, in the absence of risk events, they can be more successful. On the other hand, in risk events, they suffer greater consequences, thus, they have a better grasp of the impact of events when dealing with severe risks. That is, when the risks are low, mono-crops respond well, when the risks are higher, a multi-crop approach may be more suitable.

The results of this study devise crucial policy implications for designing adaptations to organic cocoa national policy, which would involve, for example, better technical assistance, credit, and investment in the development of diversified practices and cocoa plants' selection, which respond to poverty and climate variability. They can be used to recommend governance measures to lead livelihood strategies to a higher sustainability level in all dimensions and the adoption of climate change adaptations. For instance, the roles of research, knowledge transfers and extension programs in promoting more resilient and sustainable livelihood strategies are vital to promulgating best practices and the ecosystems' preservation. Hence, it is crucial to progress in research, development and innovation (R&D&I) and gather the essential knowledge to be able to move current OCP livelihood strategies to new cleaner circular business models.

Finally, in terms of practical implications, the research demonstrated several factors with potential to improve organic cocoa livelihoods, but also obstacles, especially in terms of formal credit access, infrastructures scarcity, actions to deal with risk events and trust in institutions and governance practices. These may deter poorer smallholders from diversifying their income sources and improve their social wellbeing. The engagement of producers in social programs and policies that facilitate access to formal finance, could encourage small business livelihood strategies and improve transparency and trust in organic cocoa-dependent communities.

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## APPENDIX

**Table A1.** Variables definition and descriptive statistics.

| Variable | Description | Total sample | | | | | LS1 Mono-crop | | LS2 Bi-crop | | LS3 Multi-crop | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Obs. | Mean | Standard Deviation | Min | Max | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| Crops | Number of crops | 809 | 2,220 | 0,922 | 1,0 | 7,0 | 1,000 | 0,000 | 2,000 | 0,000 | 3,628 | 0,865 |
| Feminine gender | 0=male; 1= Female | 809 | 0,330 | 0,471 | 0,0 | 1,0 | 0,313 | 0,466 | 0,374 | 0,484 | 0,217 | 0,413 |
| Age | Age of farmers | 809 | 48,477 | 12,291 | 15,0 | 88,0 | 52,896 | 11,643 | 48,156 | 12,042 | 46,572 | 12,786 |
| Family size | Number of male and female members | 810 | 4,231 | 1,962 | 1,0 | 12,0 | 3,643 | 1,893 | 4,156 | 1,896 | 4,828 | 2,049 |
| Education level | 1=no studies; 2=Primary; 3=secondary; 4= Graduate | 764 | 2,205 | 0,492 | 1,0 | 4,0 | 2,165 | 0,396 | 2,148 | 0,462 | 2,401 | 0,581 |
| Number of professional training courses | Number of training courses enrolled | 810 | 1,183 | 0,720 | 0,0 | 6,0 | 1,252 | 0,590 | 1,202 | 0,632 | 1,083 | 0,980 |
| Number of members on-farm work | Family members with farm work | 810 | 0,886 | 0,739 | 0,0 | 3,0 | 0,800 | 0,829 | 0,868 | 0,713 | 0,994 | 0,744 |
| Number of members off-farm work | Family members with off-farm work | 810 | 0,412 | 0,538 | 0,0 | 3,0 | 0,313 | 0,466 | 0,399 | 0,506 | 0,511 | 0,647 |
| Perception of social class | 1=very low; 2=low; 3=low average; 4=average; 5=high average; 6=high | 810 | 2,816 | 0,731 | 1,0 | 6,0 | 2,739 | 0,869 | 2,837 | 0,603 | 2,806 | 0,940 |
| Income from agricultural selling | Percentage of income from agricultural selling | 810 | 54,640 | 25,585 | 25,0 | 100,0 | 57,548 | 18,366 | 58,035 | 25,440 | 43,089 | 26,690 |
| Income from subsidies (human development and others) and remittances from emigrants | 0=do not receive subsidies; 1=receive subsidies | 810 | 0,037 | 0,189 | 0,0 | 1,0 | 0,000 | 0,000 | 0,023 | 0,151 | 0,100 | 0,301 |
| Insurances and loans | 0=do not have insurance and loans; 1=have insurance and loans | 810 | 0,072 | 0,258 | 0,0 | 1,0 | 0,052 | 0,223 | 0,054 | 0,227 | 0,133 | 0,341 |
| Cacao area | Hectares | 810 | 1,931 | 0,812 | 0,5 | 12,5 | 2,084 | 0,422 | 1,903 | 0,874 | 1,915 | 0,807 |
| Cacao total production | Kilos | 782 | 1110 | 763,069 | 1,5 | 9600 | 983 | 877,040 | 1066 | 629,593 | 1341 | 992,544 |
| Banana area | Hectares | 662 | 1,920 | 0,839 | 0,5 | 12,5 | 1,625 | 0,250 | 1,912 | 0,836 | 1,947 | 0,858 |
| Banana total production | Kilos | 658 | 939 | 1222,185 | 20,0 | 12000 | 2000 | 0,000 | 725 | 932,667 | 1520 | 1676,375 |
| Access to potable water | 0=without access; 1=with access | 786 | 0,355 | 0,479 | 0,0 | 1,0 | 0,200 | 0,402 | 0,389 | 0,488 | 0,360 | 0,482 |
| Access to electricity | 0=without access; 1=with access | 786 | 0,983 | 0,128 | 0,0 | 1,0 | 1,000 | 0,000 | 0,982 | 0,132 | 0,975 | 0,156 |
| Access to harvest storage | 0=without access; 1=with access | 785 | 0,760 | 0,427 | 0,0 | 1,0 | 0,939 | 0,240 | 0,821 | 0,384 | 0,438 | 0,498 |
| Access to transportation | 0=without access; 1=with access | 785 | 0,753 | 0,432 | 0,0 | 1,0 | 0,939 | 0,240 | 0,813 | 0,390 | 0,425 | 0,496 |
| Access to roads | 0=without access; 1=with access | 785 | 0,768 | 0,422 | 0,0 | 1,0 | 0,730 | 0,446 | 0,821 | 0,384 | 0,625 | 0,486 |
| Access to landline | 0=without access; 1=with access | 785 | 0,028 | 0,165 | 0,0 | 1,0 | 0,035 | 0,184 | 0,022 | 0,146 | 0,044 | 0,205 |
| Access to mobile phone | 0=without access; 1=with access | 785 | 0,930 | 0,256 | 0,0 | 1,0 | 0,983 | 0,131 | 0,902 | 0,298 | 0,981 | 0,136 |
| Access to internet | 0=without access; 1=with access | 785 | 0,173 | 0,379 | 0,0 | 1,0 | 0,130 | 0,338 | 0,145 | 0,353 | 0,294 | 0,457 |
| Access to TV and radio | 0=without access; 1=with access | 785 | 0,968 | 0,215 | 0,0 | 1,0 | 1,000 | 0,000 | 0,951 | 0,265 | 1,000 | 0,000 |

| Variable | Description | Total sample | | | | | LS1 Mono-crop | | LS2 Bi-crop | | LS3 Multi-crop | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Obs. | Mean | Standard Deviation | Min | Max | Mean | Standard Deviation | Mean | Standard Deviation | Mean | Standard Deviation |
| Access to health centre | 0=without access; 1=with access | 785 | 0,764 | 0,425 | 0,0 | 1,0 | 0,965 | 0,184 | 0,821 | 0,384 | 0,438 | 0,498 |
| Access to schools | 0=without access; 1=with access | 784 | 0,902 | 0,298 | 0,0 | 1,0 | 0,991 | 0,093 | 0,910 | 0,287 | 0,811 | 0,392 |
| Access to extension services | 0=without access; 1=with access | 784 | 0,711 | 0,453 | 0,0 | 1,0 | 0,904 | 0,295 | 0,786 | 0,411 | 0,333 | 0,473 |
| Belong to CECAB | 0=do not belong to CECAB; 1= belong to CECAB | 810 | 0,522 | 0,500 | 0,0 | 1,0 | 0,800 | 0,402 | 0,589 | 0,492 | 0,150 | 0,358 |
| Satisfaction with cooperatives | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 754 | 4,507 | 0,663 | 2,0 | 5,0 | 4,774 | 0,578 | 4,496 | 0,606 | 4,331 | 0,831 |
| Trust level in neighbours | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 799 | 3,564 | 0,905 | 1,0 | 5,0 | 3,887 | 0,542 | 3,670 | 0,821 | 3,040 | 1,104 |
| Trust level in civil organizations | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 754 | 3,935 | 0,590 | 1,0 | 5,0 | 3,965 | 0,476 | 3,974 | 0,498 | 3,775 | 0,878 |
| Trust level in agricultural organizations | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 799 | 2,355 | 0,920 | 1,0 | 5,0 | 2,070 | 0,558 | 2,470 | 0,934 | 2,207 | 1,010 |
| Trust level in district council | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 799 | 1,070 | 0,388 | 1,0 | 5,0 | 1,070 | 0,413 | 1,041 | 0,314 | 1,155 | 0,531 |
| Trust level in local council | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 799 | 1,064 | 0,350 | 1,0 | 5,0 | 1,052 | 0,292 | 1,035 | 0,305 | 1,155 | 0,474 |
| Trust level in cooperatives | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 754 | 4,521 | 0,682 | 1,0 | 5,0 | 4,861 | 0,560 | 4,518 | 0,629 | 4,254 | 0,820 |
| Trust level in government | 1=none; 2=just a little; 3=indifferent; 4=High; 5=very high | 799 | 0,431 | 0,220 | 1,0 | 5,0 | 1,087 | 0,431 | 1,026 | 0,220 | 1,109 | 0,532 |
| Perception of the likelihood of risks occurring | 1=low probability … 7=high probability | 809 | 2,599 | 0,804 | 1,3 | 5,8 | 2,252 | 0,454 | 2,471 | 0,725 | 3,185 | 0,900 |
| Perception of risk impact severity | 1=low impact … 7=high impact | 809 | 4,729 | 0,615 | 1,8 | 6,3 | 4,522 | 0,520 | 4,733 | 0,503 | 4,852 | 0,875 |
| Perception of the degree of self-control of the impact | 1=low control … 7=high control | 809 | 4,004 | 0,326 | 1,6 | 5,1 | 3,975 | 0,391 | 4,024 | 0,255 | 3,965 | 0,440 |
| Perception of the importance of risk management tools | 1=very inadequate… 7=very adequate | 809 | 4,918 | 0,524 | 1,5 | 7,0 | 4,971 | 2,917 | 4,958 | 1,500 | 4,771 | 1,750 |
| Perception of joining a cooperative - functional value | 1=strongly disagree…7=totally agree | 809 | 5,705 | 0,547 | 3,3 | 7,0 | 5,835 | 0,310 | 5,717 | 0,535 | 5,585 | 0,667 |
| Perception of joining a cooperative - emotional value | 1=strongly disagree…7=totally agree | 809 | 5,848 | 0,647 | 2,3 | 7,0 | 6,035 | 0,281 | 5,867 | 0,582 | 5,674 | 0,904 |
| Perception of joining a cooperative - social value | 1=strongly disagree…7=totally agree | 809 | 5,952 | 0,421 | 3,3 | 7,0 | 6,026 | 0,283 | 5,941 | 0,402 | 5,935 | 0,530 |
| Perception of joining a cooperative - monetary value | 1=strongly disagree…7=totally agree | 809 | 5,949 | 0,405 | 3,7 | 7,0 | 5,977 | 0,210 | 5,969 | 0,344 | 5,874 | 0,604 |