Journal of Agriculture and Food Research 22 (2025) 102051

Contents lists available at ScienceDirect

Journal of Agriculture and Food Research

journal homepage: www.sciencedirect.com/journal/journal-of-agriculture-and-food-research

# Sustainable cocoa production: a question of taste or survival? Eliciting farmers' preferences with a two-step choice experiment

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ABSTRACT

The transition to sustainable agricultural production (SAP) is a worldwide challenge, especially for farmers in the Global South who face production and commercialization challenges, often compounded by political and economic instability. Despite efforts to promote SAP, farmers often remain reliant on conventional agriculture and dependent on established trading systems. To better understand cocoa farmers' preferences and elicit options for a change, we conducted a two-step choice experiment (CE) - before and after a deliberative workshop - in two regions of Ecuador: in the coast and in the Amazon. The CE comprised five attributes: (i) production systems, (ii) commercialization channels, (iii) microclimate, (iv) recommendations from various actors, and (v) a monetary premium on the product price. Despite providing a deliberation space, cocoa farmers' preferences remained relatively stable in both regions. Farmers showed a preference for organic or natural production systems and recommendations from governmental entities. Regarding commercialization, intermediaries have a strong influence in the cocoa supply chain, as farmers mainly preferred to commercialize through this channel. The positive effects on the microclimate by introducing shadow trees did not outweigh the perceived disadvantages. Furthermore, we found that appropriate communication channels and tailored technical recommendations could support the widespread adoption of SAP. Our findings demonstrate that although farmers' stated preferences indicate a willingness to change their production and trade systems, socio-economic conditions can be a major obstacle for an actual implementation in practice. Therefore, ensuring stable and equitable conditions for cocoa production and commercialization is essential for successfully promoting sustainable agricultural practices.

## 1. Introduction

The current global food system fails to meet sustainability goals [1,2], leading to negative environmental impacts and undermining economic and social objectives along the food supply chain. The urgent need for a transition to more sustainable agricultural practices (SAPs) is no longer a matter of choice but a necessity [3]. To be a truly viable alternative for farmers, SAPs should promote greater inclusivity within the supply chain and improve access to stable revenues and profitable production systems. In particular, more and more consumers in the Global North are demanding for high-quality products emphasizing the importance of sustainability, which includes aspects such as biodiversity conservation, food security, economic prosperity, and socio-cultural values [4]. Therefore, economies in the Global South are heavily influenced by the demand of the Global North, which often prescribes production priorities and practices [5]. Consequently, farmers face significant challenges and pressure when trying to adopt or transition to more sustainable practices [6], especially when sustainability is narrowly understood as being limited to organic production systems [7]. While some governmental and non-governmental organizations support the adoption of SAPs, their successful implementation relies on a complex interplay of socioeconomic, demographic, political and environmental factors, along with farmers' individual preferences [8–14]. Therefore, understanding and including farmers' preferences and constraints is crucial for improving policy formulation, program development, and encouraging the implementation of sustainable practices.

Individual preferences are shaped by many factors, including socio-demographic characteristics, social environments and education levels [15,16]. A clear example of this can be seen among smallholder farmers in the countries from the Global South. These farmers often experience challenges with respect to agricultural management and product commercialization, resulting in everyday concerns and aspirations for resilience, sustainable practices, and equitable market access [17,18]. Smallholder farmers often select their production systems based on

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https://doi.org/10.1016/j.jafr.2025.102051
Received 23 January 2025; Received in revised form 8 May 2025; Accepted 25 May 2025
Available online 29 May 2025

utilitarian needs rather than hedonic desires, as their decisions are primarily influenced by practical factors, such as food security, income generation, and risk mitigation [19,20]. Limited resources, including financial constraints and land scarcity, as well as market barriers, and lacking access to agricultural tools and technology, further shape these decisions, compelling farmers to weigh the initial investment face to the potential benefits. Consequently, farmers often prioritize systems that ensure economic survival over personal preferences [21]. Ultimately, while individual preferences and interests play a role, the overall focus remains on what is feasible and essential to their livelihoods.

In the context of global agricultural transitions, a critical question emerges: do farmers genuinely have a choice in selecting their production systems? The global endeavor to shift towards SAPs provides opportunities, but socio-economic constraints and persistent challenges often severely restrict farmers' options, particularly evident in supply chains such as cocoa [22]. Consequently, the primary focus — encompassing farmers, researchers, and government stakeholders — has been on prioritizing systems that maximize productivity, often at the expense of other potential benefits like connection to nature, or enhancing community engagement [23,24]. Although the aspirations of smallholder farmers adopting sustainable practices offer considerable promise for transforming the food system at global scale [25], the realization of these goals is confronted with a number of significant obstacles at the local level [26–29]. The prevailing socio-economic and political structures frequently create conditions that are oppressive, thereby reducing farmers' capacity to implement the desired changes [30,31].

This study is motivated by the need to understand farmers' preferences within the cocoa supply chain in Ecuador. We employ a two-step choice experiment (CE) — before and after a deliberative workshop - to explore cocoa farmers' preferences and comprehension of production and commercialization dynamics. Our research delves into the heterogeneity of cocoa farmers' preferences for various production systems, commercialization channels, and other critical aspects of the supply chain. Departing from conventional stated preference methods, our approach incorporates a deliberative workshop that complements the focus on individual views by broader community perspectives related to the cocoa supply chain. This approach addresses a common critique of choice experiments related to the assumption that respondents' preferences are built on prior knowledge and stable [32]. Whether this is the case or not, crucially depends on how familiar respondents are with the topic in question and the survey [33]. Based on our extensive preparation through focus groups and pretests involving cocoa farmers, we assume that they were familiar with the attributes and levels presented in the CE. Nevertheless, preferences might change during deliberation processes due to discussion, learning, time to reflect and group dynamics, but they can also remain stable and well-defined over time [34,35]. The aim of our two-step choice experiment was to identify possible preference changes through deliberation when taking the broader social and environmental context into account [36]. Therefore, we conducted deliberative workshops allowing to discuss advantages and disadvantages of the different attribute levels, and to assess realistic management options. Our approach contributes to opening a discussion on the realities behind the cocoa supply chain based on farmers' preferences. In the context of countries in the Global South, as Ecuador, there is an urgent need for a transition to more environmentally friendly agricultural practices. For such an endeavor to succeed, it is essential to understand the social and economic complexities behind the adoption of production systems, technical recommendations, and commercialization channels, as well as the role of applied research in this context.

## 2. Methods

### 2.1. The study sites

The study was conducted in Ecuador, which is the third largest global producer of cocoa after Ivory Coast and Ghana [37]. According to the public information system "Sistema de Información Pública Agropecuaria - SIPA" (2024), the Ecuadorian cocoa production is mainly concentrated in the coastal and Amazon region, but it is also possible to find cocoa production in the mountain region up to an altitude of 1400 m above sea level. The selection of the research location was therefore purposively determined on the basis of the cocoa production volume in the two regions previously mentioned (see Fig. 1). In the coastal region, cocoa is produced in the provinces of Los Ríos (26 % of the national production), Guayas (18 %), Manabí (17 %), Esmeraldas (14 %), El Oro (3 %), Santo Domingo (6 %), and Santa Elena (0.25 %). In the Amazon region, the distribution is as follows: Sucumbíos (3 %), Orellana (2 %), Napo (1.50 %) y Zamora Chinchipe (0.07 %). The 9 % remaining are distributed in provinces like Imbabura, Pichincha, and Cañar.

The Guayas province is located in the coastal region of Ecuador with a climate characterized by two seasons: 'dry' and 'rainy'. The mean precipitation in the rainy season is 260 mm, with a mean temperature of 29 °C. In contrast, the mean precipitation in the dry season is 33 mm, with a mean temperature of 27 °C [38]. Such changes in the temperature and precipitations can have impact on the cocoa production, as the cocoa tree can be sensitive to hydrological stress. Lahive et al. (2018) found that cocoa is predicted to be vulnerable to climate change, as high temperatures and low precipitation will likely affect its growth and productivity [39]. Cocoa production in Guayas employs approximately 276,580 farmers, representing around 6 % of the province's population, with 14 % of them being women. Family farming, which is understood as a distinct form of agricultural work, constitutes 53 % of the agricultural sector, with women representing 22 % of the family farmers [40]. Family farming plays a crucial role in food security and rural employment in countries of the Global South, characterized by small-scale operations where family labor is predominant [41]. 67 companies (57 % of all Ecuadorian cocoa producers) are involved in cocoa production in the Guayas province [42], indicating a high market coverage. In this province, agricultural practices in the cocoa sector remain largely conventional and focused on export markets [43].

The Napo province is located in the Amazon region. The weather in Napo, with its tropical climate, does not follow the traditional seasonal patterns observed in other Ecuadorian regions. The dry season is characterized by an average rainfall of 249 mm, with an average temperature of 14 °C. The rainy season is characterized by an average rainfall of 368 mm, but with a similar average temperature of about 14 °C [38]. The cocoa production in the Napo province provides employment for approximately 23,330 farmers, which represent about 18 % of the total population of the province with women comprising 40 % of this workforce. A majority of 86 % of the cocoa farmers are involved in family farming, of which 45 % are women. Cocoa production in Napo province is characterized by the grouping of different agricultural organizations, such as the "Asociación de Productores Kichwas Kallari" (Kichwas Kallari Producers Association), "Tsatsayaku", and "Wiñak". Most of the members of these organizations are Kichwas people, an ethnic population whose mother tongue is 'Kichwa', with Spanish being their second language. As Kallari is the region's biggest association, most cocoa farmers are members of this organization and engaged in organic production. However, the expansion of monocultures and intensive cattle ranching continues to shape the landscape [13,44]. Colonization has influenced these indigenous populations, but they still preserve their language, traditions and diverse agricultural production systems [45]. However, due to market pressures and the colonization process, traditional knowledge is at risk of extinction.

### 2.2. Definition of attributes and levels of the choice experiment

The attributes of our CE were selected to explore cocoa farmers' preferences with respect to their production systems, micro-climate, commercialization channels, and technical recommendations. Our study comprised three steps: (i) identification of the choice experiment attributes and their respective levels, (ii) study design and data

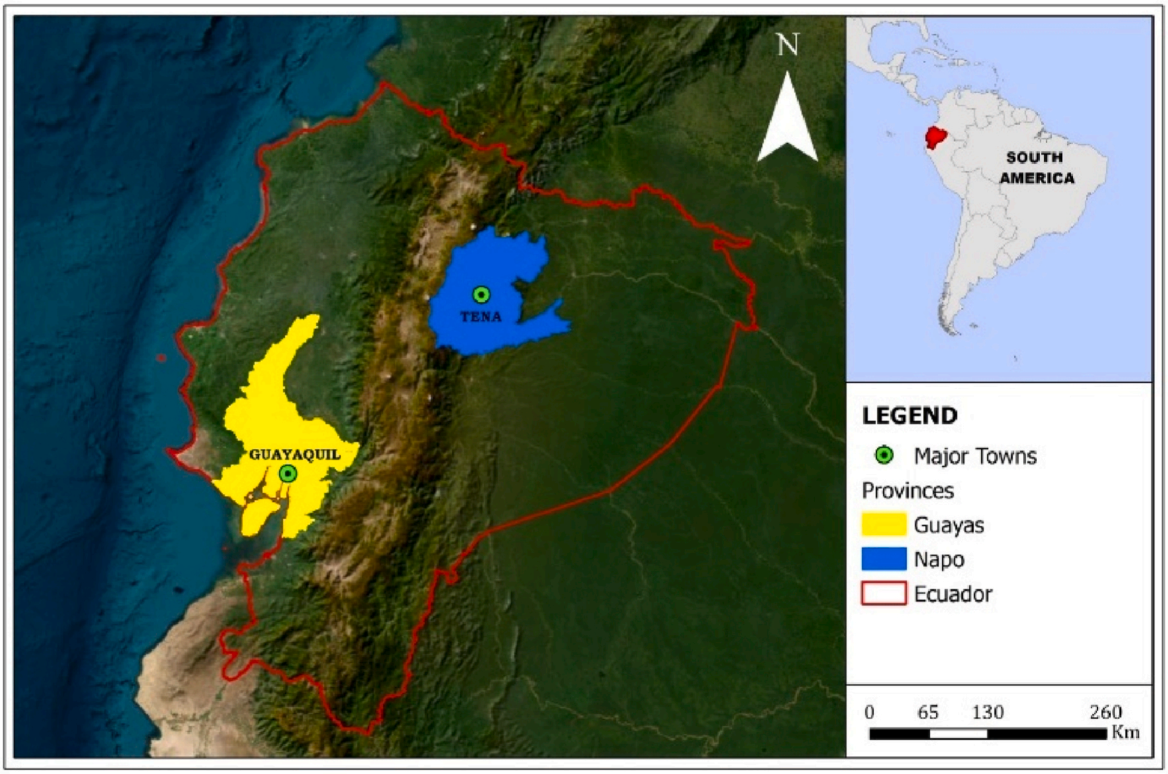


**Fig. 1.** Regions of data collection events in case studies: Guayas and Napo, Ecuador.

collection, and (iii) modeling and analyses.

The attributes included in the CE were selected and defined based on focus group discussions held in October 2022 with cocoa farmers from both regions. The focus group discussions employed participatory mapping, a visual and interactive tool to encourage discussion among participants [46]. Farmers were asked to draw or write the products and services provided by cocoa trees, the conditions necessary for healthy production, the agricultural practices and inputs used on their farms, and the cultural significance of their work. They were also invited to indicate the individual importance of the products and services identified. These aspects align with the dimensions of ecosystem services outlined in the Millennium Ecosystem Assessment [47]. More than twenty farmers from Guayas and Napo participated in these focus group discussions, which enabled us to identify the most important aspects of their cocoa agroecosystems (see Fig. 2). The farmers' perceptions provided evidence for determining the most relevant attributes for our CE.

After reviewing the available literature on cocoa agroecosystems [48–54], we pre-selected several attributes with the cocoa farmers, and finally determined those attributes capturing the most important characteristics of cocoa production as perceived and prioritized by the farmers. The levels of the attributes, which refer to different peculiarities of each attribute, were chosen and adapted to the specific context in both regions to improve the reliability of the CE. The final CE consisted of five attributes: (i) type of production system, (ii) microclimate, (iii) recommendations, (iv) commercialization channels, and (v) a price premium. A list of the attributes and their levels is shown in Table 1.

During the workshop, cocoa farmers were introduced to the experiment through the following question: "Imagine yourself making a decision on the following options for your own farm. Which one would you select?" Participants were asked to consider all the attributes presented in the choice sets. Although the exercise was hypothetical and non-binding, they were encouraged to respond as if they were making a

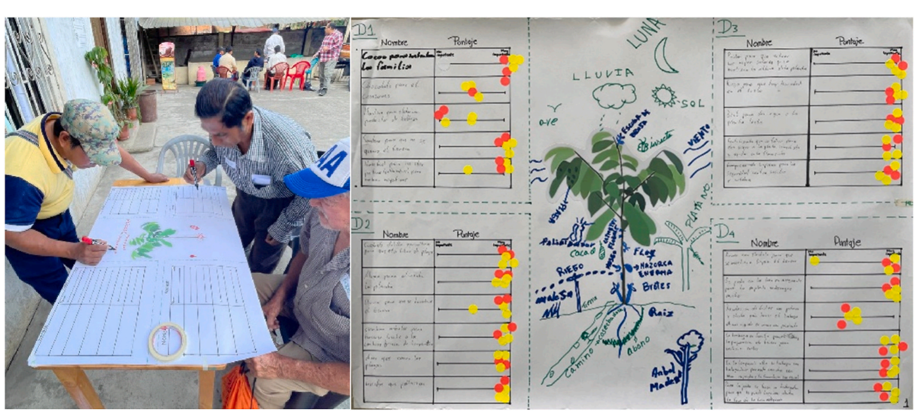


**Fig. 2.** Focus group discussions for identifying CE attributes in Naranjal (Guayas province), based on agroecosystem services categories from the Millennium Ecosystem Assessment (MA 2005).

**Table 1**
Attributes for the choice experiment.

| Attribute | Description | Level | |
|---|---|---|---|
| Production system | The cocoa production system includes the agricultural management practices used by the farmer. | 1 | natural production |
| | | 2 | certified organic production |
| | | 3 | production with low use of chemical inputs |
| | | 4 | conventional production |
| Microclimate | The microclimate is the localized climate of the land, influenced by having fruit trees, wood trees and cocoa. | 1 | wood trees + cocoa trees |
| | | 2 | wood trees + fruit trees + cocoa trees |
| | | 3 | fruit trees + cocoa trees |
| | | 4 | cocoa trees |
| Recommendations | Recommendations on cocoa production come from various actors. | 1 | government |
| | | 2 | farmers |
| | | 3 | scientists |
| | | 4 | no specific recommendation |
| Commercialization channels | These channels are the pathways through which cocoa goes along the supply chain from the farmer to the consumer. | 1 | public institutions |
| | | 2 | intermediaries |
| | | 3 | private companies |
| | | 4 | agricultural organizations |
| Additional payment/ price premium | The additional payment is a premium added to the price of dry cocoa per quintal received by the farmer. | 1 | +5 $/qq[a] |
| | | 2 | +10 $/qq |
| | | 3 | +15 $/qq |
| | | 4 | +20 $/qq |
| | | 5 | +25 $/qq |

[a] qq refers to a quintal, which is weight unit equivalent to 100 pounds of dried cocoa beans.

real decision. This served as a form of cheap talk to mitigate a possible hypothetical bias [55].

The first attribute refers to the specific **type of production system**, for which we identified four levels: 'natural', 'certified organic', 'low use of chemical inputs', as well as 'conventional production'. In our study, certified organic production means a production without using agrochemicals. Similar to organic production, the alternative natural production is a chemical-free practice aligned with Fukuoka's "do-nothing" approach [56], but without formal certification. While this approach minimizes the human intervention, allowing nature to take its course, Ecuadorian cocoa farmers often apply weeding in this agricultural production system. As a further option, farmers might employ low chemical input practices. Authors, such as Vasco et al. (2021) and Hurtig et al. (2003), have suggested the controlled use of chemical inputs, guided by regulations related to pesticides in rural areas, as an effective way for farmers to maintain healthy crops and achieve economic prosperity [57,58]. However, inherent risks due to the toxicity of these chemicals should not be ignored [59,60]. Therefore, assessing whether this production system can become more sustainable by using fewer chemicals, so farmers are less exposed to hazardous substances, is essential. The fourth attribute level is conventional production characterized by the regular application of chemical fertilizers and herbicides [61]. While the importance of regulating or even restricting these chemical inputs has been extensively discussed in the literature [57–60], some researchers, such as Dumont et al. (2020), proposed a more nuanced approach. They suggested a potential coexistence of conventional and natural/organic production methods, contributing to the debate on the transition towards sustainable agriculture.

The second attribute is **microclimate**, which is determined by the composition of plants and trees as well as the degree of canopy closure in an agroforestry system. The selected levels for this attribute encompass the potential combinations of fruit and wood trees with cocoa plants. Favorable microclimatic conditions can help to mitigate the effects of extreme weather conditions, for example by reducing the drought stress of cocoa trees [62]. For instance, full-sun monocultures cannot control fluctuations of temperature and relative humidity, causing a decrease in cocoa productivity [63]. In our CE, cocoa farmers could combine their cocoa trees with fruit trees (e.g., banana, plantain, and papaya), as well as with trees for wood production (e.g., teak, guaiac, laurel, and cedar). Such combinations of shade trees can lead to potential ecological advantages, and contribute to increasing revenues by selling additional products [64], but they may also increase the prevalence of diseases [65].

The third attribute, **recommendations,** relates to possible sources of formal and informal information on cocoa production systems, and how to improve them. Such technical advice can be provided, e.g., by the government, scientists, or neighboring farmers. The selection of this attribute was motivated by the aim of capturing information channels that cocoa farmers prefer to improve agricultural management [66]. In general, technical information can be used to increase cocoa farmers' skills and decision-making in their production systems [67,68] and to take environmental aspects into account. Such information can be conveyed by sharing experience between farmers themselves [69]. Besides, the government can provide knowledge through extension services. In Ecuador, the Ministry of Agriculture and Livestock provides technical assistance to farmers, which focuses on enhancing their knowledge and equipping them with the necessary resources/material and support to effectively improve yields and to manage pests. However, this assistance is limited by financial constraints [70], resulting in some rural areas being 'overlooked'. As a further option, scientists can also support and improve farmers' production practices, for instance by involving them in research activities, such as farm discussion groups. These interactions between farmers and scientists facilitate exchange and collaboration. Here, it is crucial to acknowledge the need to translate scientific knowledge into plain and easy-to-understand language, specifically in real-world settings, thereby bridging the gap between research and practice [71].

The fourth attribute refers to possible **commercialization channels**, e.g., through intermediaries or middleman, private enterprises, agricultural organizations, and public institutions**.** Historically, cocoa farmers in both study regions have commercialized their harvests through intermediaries [72], who collect cocoa beans, usually without long-term relationships with farmers. A further level of this attribute is the direct selling by farmers to private enterprises, such as 'Cocoa Premium' in the Amazon region [64], which are considered a more direct channel to cocoa farmers, often involved in the export of cocoa beans and their derivatives, such as chocolate [21]. The third level is selling cocoa production to agricultural organizations, which are established as social organizations with a commitment to caring for their members [73], such as 'Kallari' in the Amazon [74]. Finally, the fourth level of the attribute reflects the option of public institutions to take over commercialization activities in the supply chain.

Lastly, the monetary attribute is defined as a **premium added to the current price of dry cocoa per quintal** (qq = weight unit equivalent to 100 pounds of dried cocoa beans) to be received by the farmers. This attribute comprises five levels ranging from $5/qq to $25/qq in $5 increments. Given that typical cocoa prices range from $85/qq to $120/qq [64], these levels were set to reflect the range between the minimum and maximum prices recorded for dry cocoa, which refers to fermented and dried beans, ready for processing into chocolate.

### *2.3. Study design and data collection*

To determine cocoa farmers' preferences within the cocoa supply chain we adopted a stated-preference method. Cocoa farmers were asked to assess 12 choice sets, choosing between two unlabeled options and the option not to choose any of the other two options (i.e., to opt out) (see Fig. 3). Mangham et al. (2009) emphasize that conducting

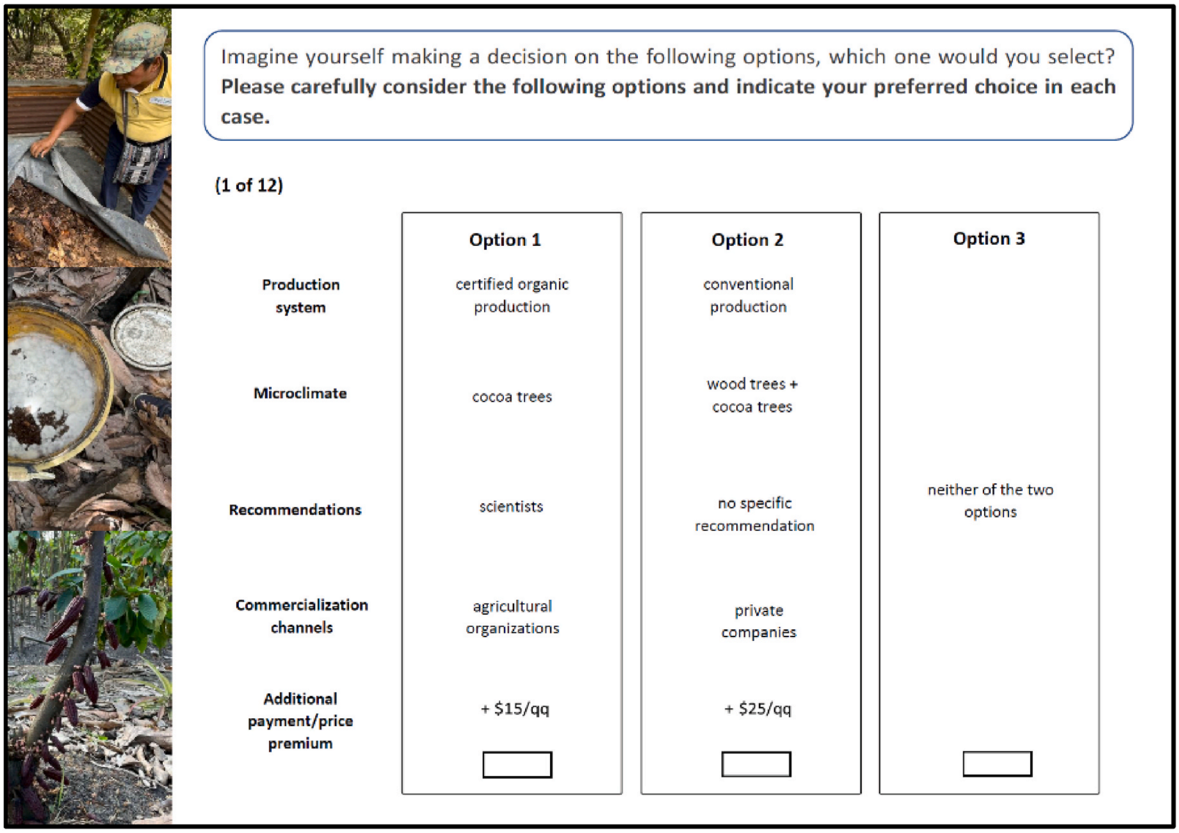


**Fig. 3.** Example of a choice set.

choice experiments in low-income countries with a low level of literacy requires to reduce the generally used high number [75], e.g., 18 choice sets, depending on how cognitively demanding the choice experiment is. Presenting 12 subsequent choice sets seems within an acceptable range [76–78]. Based on these findings we concluded that our CE comprises a reasonable number of choice sets and should not have overloaded the respondents' cognitive abilities. Following the selection of the final attributes and levels, the CE was developed and validated using the Sawtooth Software and the Discover Web Application [79], in adherence to established best practices [80]. The choice tasks were constructed using a balanced-overlap design in Sawtooth [81]. To ensure consistency in the analysis, we fixed the design by using the first generated set of 12 choice sets for all participants [82], which integrates elements of both complete enumeration and randomization methods. The study sample included 255 farmers, 114 in Guayas and 141 in Napo. In Guayas, the CE resulted in 1368 observations (114 respondents × 12 choice sets × 1 chosen option). In Napo, 1692 observations were analyzed using the same methodology. A combination of non-probability and probability sampling methods was used. Guayas and Napo were selected through a non-probability sampling method due to their significance in cocoa production and concentration of agricultural organizations, as reported by the Sistema de Información Pública Agropecuaria - SIPA" (2024). Cocoa farmers were recruited through formal invitations and on-site visits, but farmers who participated in the focus groups discussion were excluded from the final survey to minimize response bias from prior exposure to the topic [83]. In Guayas, 14 agricultural organizations were formally invited via letter and in-person visits, while in Napo, outreach efforts targeted three agricultural organizations and one decentralized autonomous government in Chontapunta, a rural parish in the Napo-Amazon region. The on-site visit was made by the support of two promoters, one for each region. These promoters have local knowledge of the areas and have built trustful relationships with the farmers. They were responsible for approaching agricultural organizations and other stakeholders in the territory to present the research project, for instance, using an informative leaflet designed by the project team. The leaflet outlined the purpose of the research project, the expected outcomes, and the people involved in the activities. This information was first shared with the organization's leaders and then communicated to their members, enabling them to make an informed decision about their participation [84]. The aim was to increase the transparency of the research activities and encourage more interactive participation by clarifying expectations beyond formal decision-making processes [85]. Additionally, the promoters followed up on the farmers' commitments to participate and secure their consent to use the survey information for scientific analyses. In addition, the promoters were responsible for collecting, building and refining the population frame based on the lists of cocoa farmers provided by the regional agricultural organizations and governmental agencies of the Ministry of Agriculture in Ecuador. These lists include information such as names, type of production system, telephone number, email, and cocoa plot size. The final lists of available cocoa farmers were used to apply a random sample approach with a 95 % confidence level and a precision of 0.05 and to verify which farmers were selected to participate in the study [86]. The sample was designed to ensure proportional representation of farmers across different production systems and gender. In case potential participants were not interested or could not participate, a replacement sample was defined to substitute these farmers.

To collect the data from the respondents, first, we conducted an in-person pretest of the CE in November 2023 with representatives of the agricultural organizations. 24 farmers participated in the pilot survey: 12 in Guayas and 12 in Napo. The pre-test was carried out with the support of researchers from the Escuela Superior Politécnica del Litoral (ESPOL, Ecuador) and local promoters. The farmers' feedback was compiled into a presentation by the local researchers, ESPOL and promoters, which was shared with the research team. This input was used to refine the CE and to rephrase questions for a better understanding [87]. For example, most farmers stated that it was not clear how the attribute level combinations were determined. Therefore, a practical example of how to develop the CE was introduced to explain how this method works. Based on the pretest feedback, the final survey was designed. The survey was conducted in the two regions between January and February 2024. Farmers who participated in the pretest were excluded from the final survey. The primary data collection was organized in several separated in-person workshops across the study regions, with an average of 30 participants per workshop. The quantitative data was collected in person from cocoa farmers using a pretested structured survey. During the data collection process, we counted on the additional support of researchers from the ESPOL and the Universidad Pablo de Olavide (UPO, Spain). The researchers worked in groups of 7–8 farmers, and the CE was conducted individually with the guidance of the researchers as table hosts, which presented the available options one by one and then asked the farmer to make their choice. Given that the survey was presented in paper format with the intention to facilitate the work with farmers during the workshops, the responses were subsequently tabulated and analyzed by the research team using IBM SPSS and R (R Core Team, 2023) within the RStudio environment specifically.

The final survey consisted of five parts. The first part introduced the research project and presented the CE. The second section of the survey concerned questions regarding the farmers' socioeconomic situation. The third section addressed specific farm management aspects. The fourth section contained questions with respect to the farmers' well-being. Finally, in the fifth section, the farmers were asked to participate in a second CE, which included the same 12 choice sets that were presented in the first part. Before the second CE, we conducted a deliberative workshop designed to inform farmers and engage them in discussions about the attributes presented in the CE. The one-hour workshop was facilitated by researchers, who acted as table hosts, using structured questions focused on the CE attributes. During the discussion, cocoa farmers had the opportunity to explain, reflect, and refine their preferences while interacting with other fellow farmers. Besides the CE, the survey incorporated supplementary questions to capture a broader range of contextual factors relevant to cocoa farmers. However, the primary focus of this study remains on the CE, it provides a structured and rigorous approach to analyzing farmers' preferences within the cocoa supply chain. The additional questions enrich the contextual understanding but are not the central analytical focus of this study.

### 2.4. Modelling approach and data analyses

In this study, we assumed that cocoa farmers face various options when choosing among different aspects of cocoa production systems. We adopted a random utility model, and specifically, we started with a multinomial logit model (MNL), followed by a mixed logit model (MXL) for comparison. The MXL showed a better fit with our data, and has the advantage to capture unobserved preference heterogeneity among respondents by incorporating random coefficients that vary across cocoa farmers [81–83]. Further, unlike the MNL, the MXL model does not rely on the assumption of independence of irrelevant alternatives (IIA), allowing for more flexible and realistic substitution patterns between alternatives [88,89].

The CE consisted of 12 choice sets with 5 attributes each. The utility $U_{ni}$ derived by farmer $n$ from selecting option $i$ comprised two key components. The first is $V_{ni}$, is the deterministic and observable component, a linear function of the attributes associated with option $i$. The second component, $\varepsilon_{ni}$, represented the random element or stochastic variable that captured unobserved individual preferences and characteristics [90]. Thus, $X_{ni}$ is the vector of attributes, with $\beta$ representing their specific coefficients.

$$U_{ni} = V_{ni} + \varepsilon_{ni} = \beta_i X_{ni} + \varepsilon_{ni} \quad [1]$$

The choice set included two options $i$ plus the opt-out alternative. It is assumed that cocoa farmers make their choice by maximizing their utility. Selecting option $i$ indicates that the farmer prefers a specific combination of attribute levels presented in a choice set. The probability $P_n(i)$ of the cocoa farmer n on choosing the option $i$ is the following:

$$P_n(i) = \Pr(U_{ni} \geq U_{no}) = \Pr(V_{ni} - V_{no} \geq \varepsilon_{on} - \varepsilon_{in}) \quad [2]$$

On the basis of a random parameter logit model (see Ref. [91]), where $f(\beta_k|\theta)$ is the probability density function for $\beta_i$, assuming certain distributional characteristics, such as normal, uniform or triangular [88]. In our study, we assume a normal distribution, where the coefficients can take both positive and negative values, and there is no bound in magnitude. $\theta$ is a vector with a set of parameters describing the preferences of cocoa farmers. The overall probability that respondent n chooses option $i$ is given by:

$$P\_(ni)\ |\theta = \int \mathrm{P\_(ni)}\ |\beta\, f(\beta|\theta) d\beta = \int \frac{\exp(\beta X_i)}{\sum_{j=1}^{N} \exp(\beta X_j)} ff(\beta|\theta) d\beta \quad [3]$$

Given that our study includes five observable attributes, the model specification for the deterministic component $V$ associated with the option $i$ is as follows:

$$\mathrm{V_i} = \beta_1 \mathrm{prod\_system} + \beta_2 \mathrm{micro\_clim} + \beta_3 \mathrm{recommend} + \beta_4 \mathrm{comer\_chann} + \beta_5 \mathrm{prime\_price}$$

The four parameters —*prod_system*, *micro_clim*, *recommend*, and *comer_chann*— are categorical variables that were transformed into dummy variables for the analysis, while *prime_price* is a cardinal variable representing the monetary attribute. The MXL was estimated using the Apollo package [92] and 500 Halton draws for the simulation of the log-likelihood function. In addition, Cook's Distance was analyzed to identify influential respondents and strengthen our robustness check [93,94].

## 3. Results

### 3.1. Descriptive statistics

The sample includes both male and female cocoa farmers (see Table 2). In Guayas, participants were generally older than in Napo, and the proportion of women in the sample was lower. The average household size in both regions was more than three members, and more than half of the sample resided on their farms. In terms of decision-making in cocoa production, the proportion of women and joint household decisions is higher in Napo than in Guayas. On average, participants in both regions have around 10 years of formal education. In terms of ethnic identification, most participants in Guayas identify as mestizo ("mixed" ethnicity), while in Napo the majority is indigenous. Conventional methods dominate cocoa production in Guayas, while organic certification is more common in Napo. The average size of cocoa farms is larger in Guayas, where organic fertilization is more common. Farmers in both regions reported the presence of pests. Irrigation systems are more common in Guayas. Crop yields in 2023 were higher in Guayas than in Napo. In both regions, more than half of the farmers reported receiving technical assistance related to cocoa production.

### 3.2. Insights from the pre-deliberation choice experiment

#### 3.2.1. Guayas

The MXL model results, including the maximum likelihood estimation and standard deviations, are detailed in Table 3. Overall, the results reveal that cocoa farmers, on average, show preferences in favor of organic and natural cocoa production systems compared to conventional production. Furthermore, cocoa farmers have no significant preferences for combining fruit or wood trees with cocoa trees on their farms. Farmers strongly prefer receiving recommendations on cocoa

**Table 2**
Survey statistics and socio-demographic data of the sample (n = 255).

| Variables | | Mean or percentage | |
|---|---|---|---|
| | | Guayas | Napo |
| ***Individual characteristics*** | | | |
| Age | | 53.05 (±13.68) | 48.03 (±13.68) |
| Women | | 39.5 | 58.2 |
| Household size | | 3.87 (±1.70) | 5.35 (±2.64) |
| Living in the plot | | 51.8 | 61.7 |
| Technical decisions on cocoa crop | *women* | 21.9 | 33.3 |
| | *man* | 57 | 27 |
| | *both* | 21.1 | 39.7 |
| Years of schooling | | 10.17 (±4.31) | 10.09 (±4.01) |
| Ethnical identification | *indigenous* | – | 78.7 |
| | *mestizo* | 73.7 | 19.9 |
| | *montubio* | 22.8 | 0.7 |
| | *afroecuadorian* | 1.8 | – |
| | *white* | 1.8 | 0.7 |
| ***Cocoa management*** | | | |
| Production system type | *natural* | 20.2 | 17 |
| | *organic certification* | 8.8 | 61.7 |
| | *low use of chemical inputs* | 23.7 | 10.6 |
| | *conventional* | 47.4 | 10.6 |
| Surface plot cocoa (ha) | | 28.70 (±79.02) | 15.80 (±52.98) |
| Farmers using organic fertilizers | | 22.8 | 16.3 |
| Presence of pests | | 90.4 | 86.5 |
| Irrigation system | | 87.7 | – |
| Harvest quantity in 2023 (quintals) | | 31.80 (±38.89) | 4.71 (±5.34) |
| Technical assistance | | 61.4 | 75.9 |

production from government extensionists over direct information from scientists. With regard to commercialization channels and compared to intermediaries, the option of selling cocoa production to private enterprises was highly preferred, followed by selling to agricultural organizations. In contrast, commercializing through public institutions was the inferior alternative compared to intermediaries. Finally, farmers did not show a significant preference for receiving a price premium, indicating that a compensation would not substantially influence their decisions.

#### *3.2.2. Napo*

In the MXL model, both the significance and sign of the natural and organic production coefficients indicate a strong preference among cocoa farmers for these two production systems. Interestingly, despite these preferences, conventional production systems are more favored than those with low chemical use. Concerning the microclimate, farmers significantly reject all presented combinations of fruit, wood and cocoa trees. Regarding recommendations, there is a significant preference for receiving technical advice from their community peers. Further, farmers express a stronger preference for receiving agricultural technical advice from governmental entities over those from scientists. Conversely, farmers do not show a significant preference for selling cocoa production through public institutions. Instead, farmers show a significant preference for private enterprises and agricultural organizations compared to intermediaries. Lastly, there is a strong preference for receiving a price premium, reflecting their willingness to accept changes related to the presented attribute level combinations.

### *3.3. Insights from the post-deliberation choice experiment*

#### *3.3.1. Guayas*

The second CE - conducted after the deliberative workshop - revealed that cocoa farmers' preferences remained stable in general. On average, there was a stronger inclination towards cultivating cocoa in natural system, whereas organic production was not significant anymore. Notably, cocoa farmers developed a significant aversion to combining wood and fruit trees with cocoa trees on their farms. Regarding recommendation preferences, the findings were consistent with the pre-deliberation CE. The results indicated that farmers exhibited a preference for receiving advice from the government rather than receiving none. Furthermore, farmers' preferences for commercialization channels showed a variation compared to their pre-deliberation choices: the preference for selling to private enterprises, agricultural organizations and agricultural organizations lost significance. Finally, farmers showed significant preferences for receiving a price premium.

#### *3.3.2. Napo*

Similar to Guayas, the preferences of cocoa farmers in Napo remained relatively stable after the deliberative workshop. Specifically, farmers continued to favor both natural and organic production systems, while a strong preference for conventional production compared to low use of chemicals also persisted. The rejection to integrate fruit trees with cocoa and wood trees became more pronounced. The results also show that farmers prefer technical advice from governmental entities compared to scientists or no recommendation. In terms of commercialization, farmers showed a shift in preferences towards selling their production to public institutions compared to intermediaries, while preferences for selling to private enterprises or agricultural organizations became insignificant. Lastly, the preferences for a price premium increased, indicating a more important role of the monetary compensation.

## 4. Discussion

### *4.1. Regional comparison of cocoa production*

#### *4.1.1. Production systems*

In our survey, farmers in the Guayas and Napo regions generally favor natural and organic cocoa production over conventional production. This result can be linked to the recent rise in fertilizer prices [95], such as "urea", which could influence cocoa farmers' preferences in regions like Guayas. However, in practice conventional monocultural systems still predominate, as reflected in the descriptive statistics. This could be partly due to the price-inelastic demand for chemical inputs [96]. Nevertheless, it also reflects a broader social reality, as farmers rely on practices that sustain their livelihoods [7]. The reluctance of cocoa farmers to adopt environmentally more sustainable systems, such as organic production [97], can be attributed to Guayas' longstanding export orientation of agriculture [43], especially in cocoa and other important crops in coastal Ecuador, like bananas. The continued reliance on chemical inputs, driven by the short- and mid-term pursuit of higher yields, represents a significant challenge to adopting production systems that minimize chemical inputs. Furthermore, the existing unequal distribution of land resources among smallholder farmers has resulted in notable distributional disparities in rural areas along the coast [98]. This specific context can limit farmers' ability to adopt SAPs and invest in long-term improvements.

In Napo, we found a similar situation: farmers, despite their inclination towards natural and organic systems, paradoxically often apply conventional monoculture systems. This result reveals the complex situation that farmers face when taking their decisions. Putting their preferences into practice by switching to desired production systems might be hindered by real world constraints. Satama et al. (2022) came to similar results with respect to the Amazon region, where, despite the willingness of farmers to use organic fertilizers, they continue to grow monocultures and to apply intensive cattle ranching [13]. This continuation is likely due to factors such as limited market access, financial pressure, and lack of technical support [17,18], all of which make transitioning to more sustainable systems challenging.

**Table 3**
Results of the mixed logit model in both regions before and after a deliberative workshop.

| Estimation | Guayas | | | | Napo | | | |
|---|---|---|---|---|---|---|---|---|
| | Before | | After | | Before | | After | |
| | Coefficients (s.e.) | Standard dev. (s.e.) | Coefficients (s.e.) | Standard dev. (s.e.) | Coefficients (s.e.) | Standard dev. (s.e.) | Coefficients (s.e.) | Standard dev. (s.e.) |
| ***Production system (ref. conventional)*** | | | | | | | | |
| natural | 0.508*** (0.210) | −1.316*** (0.188) | 0.782*** (0.180) | −1.045*** (0.284) | 1.036*** (0.163) | −1.005*** (0.166) | 1.482*** (0.224) | −1.071*** (0.282) |
| organic | 0.605*** (0.220) | 1.030*** (0.214) | 0.330 (0.303) | 1.649*** (0.341) | 0.797*** (0.195) | 0.898*** (0.169) | 1.060*** (0.263) | 1.504*** (0.292) |
| low use of chemicals | −0.088 (0.268) | 1.398*** (0.317) | −0.276 (0.239) | 1.468*** (0.368) | −1.131*** (0.227) | −1.053*** (0.285) | −1.608*** (0.398) | 1.637*** (0.281) |
| ***Microclimate (ref. cocoa)*** | | | | | | | | |
| wood + cocoa | −0.185 (0.204) | −0.170 (0.158) | −0.933*** (0.220) | 0.327 (0.872) | −1.045*** (0.223) | 0.289** (0.201) | −0.933*** (0.301) | 0.493 (0.536) |
| wood + fruit + cocoa | 0.064 (0.185) | −0.403** (0.217) | −0.582*** (0.218) | 0.030 (0.394) | −0.37** (0.172) | −0.034 (0.216) | −1.034*** (0.228) | 0.096 (0.240) |
| fruit + cocoa | −0.025 (0.165) | −0.446* (0.203) | −0.116 (0.169) | −0.129 (0.260) | −0.671*** (0.180) | 0.312*** (0.155) | −0.645*** (0.179) | 0.418 (0.379) |
| ***Recommendations (ref. government)*** | | | | | | | | |
| farmers | 0.168 (0.192) | 0.386** (0.194) | −0.053 (0.215) | 0.278 (0.676) | 0.372** (0.217) | −0.126* (0.314) | 0.242 (0.209) | 0.005 (0.421) |
| scientists | −0.227* (0.140) | 0.142 (0.320) | −0.111 (0.172) | 0.456** (0.254) | −0.304** (0.163) | 0.038 (0.168) | −0.324** (0.142) | −0.158 (0.667) |
| no recommendation | −0.245 (0.202) | −0.551 (0.563) | −1.567*** (0.246) | 0.626** (0.288) | −1.111*** (0.250) | −0.375** (0.196) | −2.017*** (0.336) | 0.016 (0.356) |
| ***Commercialization channels (ref. intermediaries)*** | | | | | | | | |
| private enterprises | 0.540*** (0.214) | −0.068 (0.579) | 0.208 (0.239) | 0.543 (0.462) | 0.684*** (0.227) | 0.651** (0.289) | −0.109 (0.227) | 0.675 (0.546) |
| agricultural organizations | 0.481** (0.216) | −0.942*** (0.286) | 0.084 (0.263) | −1.151*** (0.317) | 0.739*** (0.203) | −0.638** (0.215) | 0.123 (0.221) | −0.027 (3.121) |
| public institutions | −0.349** (0.184) | 0.278** (0.163) | 0.246 (0.242) | −0.801* (0.537) | −0.005 (0.181) | 0.364* (0.215) | 0.377* (0.249) | 0.495 (0.402) |
| ***Additional payment*** | | | | | | | | |
| monetary compensation | 0.007 (0.013) | 0.075*** (0.013) | 0.042** (0.019) | 0.114*** (0.016) | 0.101*** (0.020) | −0.109*** (0.010) | 0.127*** (0.021) | 0.138*** (0.027) |
| AIC | 2679.23 | | 2554.12 | | 2969.45 | | 2717.11 | |
| BIC | 2814.98 | | 2689.87 | | 3110.72 | | 2858.38 | |
| Log-likelihood | −1313.62 | | −1251.06 | | −1458.72 | | −1332.55 | |
| Prob > chi2 | 0.108 | | 0.15 | | 0.201 | | 0.27 | |

Note: Cook's Distance identified one potentially influential observation for the model Guayas-before (Observation 1/114). (*) = $p < 0.10$. (**) = $p < 0.05$; (***) = $p < 0.01$.

### 4.1.2. *Microclimate*

Despite the potential positive impact of shadow trees on the microclimate and on revenues from selling additional products, farmers in Guayas do not show significant preferences for integrating fruit or wood trees into their cocoa plantations, while farmers in Napo even significantly reject them. These preferences are deeply rooted in historical factors, where small and medium producers established monocultures, such as cocoa and bananas, driven by commodity trading booms [99]. These booms induced pressures in favor of monoculture crops, prioritizing short-term profits, pushing away from diversified systems, and leading to negative environmental impacts, such as soil depletion. At the time, policymakers even regarded deforestation as a positive contribution to economic development [99], further reinforcing these unsustainable practices. Moreover, agrarian reforms facilitated the distribution of land to landless settlers from other regions of the country. This process primarily benefited specific socioeconomic groups, particularly these new landowners [100]. As a result, the expansion of the agricultural frontier gave rise to substantial alterations in the social structures of the region, forcing farmers to engage in commercial production systems often based on monocultures [100,101].

Beside this historical background, practical evidence demonstrated potential ecological drawbacks of combining tree species. Bentley et al. (2004) found an increased prevalence of diseases in shaded cocoa, such as the 'Monilia' fungus (*Moniliophthora roreri*). Conversely, other farmers reported a reduction in the incidence of witches' broom (*Moniliophthora perniciosa*), a disease caused by fungus in shaded cocoa. This uncertainty about the consequences of introducing shadow trees might cause a reluctance of farmers to switch to more diverse production systems, and, thus, explain their preferences stated in our CE.

### 4.1.3. *Recommendations*

Farmers in Napo show a preference for recommendations of other farmers compared to government extension agents. Such an interaction and exchange within farmer communities can, on the one hand, facilitate the dissemination of specific knowledge with respect to different types of production system. On the other hand, this result highlights the existence of social capital among farmers, which has enabled and fostered collective action to strengthen indigenous community organizations [102–104]. However, the existence of a such type of social capital can simultaneously create disadvantages, if efforts of third parties fail to transfer novel scientific knowledge and agricultural techniques to the farmers due to so-called lock-in effects [105].

As an example, farmers in both regions significantly rejected recommendations from scientists. This result might be attributed to the power dynamics observed in the field or the perceived lack of involvement in research projects [106]. National as well as foreign researchers are often seen as external actors, that conduct brief studies, collect data, and prioritize rapid publication over a more profound engagement [107]. This type of research practice is sometimes characterized as "parachute science" or "helicopter research", where scientists leave the study site after finishing their research activities without disseminating their results or ensuring that their findings are applicable or beneficial to the local communities [108,109]. Consequently, the long-term impact of these projects may be compromised and the advantages to local communities could be significantly diminished. The application of practical communication tools can facilitate a comprehensive understanding of the project's objectives and results [110]. However, for these tools to be effective, they must be integrated in a strategic narrative based on local inclusivity, transparent communication, and cultural sensitivity [71]. Furthermore, to ensure the success of these communication tools, scientists must connect with local stakeholders and acknowledge their needs while simultaneously accepting their role as legitimate partners in such a collaboration.

#### *4.1.4. Commercialization channels*

Cocoa farmers in both regions significantly prefer to trade with private enterprises and agricultural organization compared to intermediaries. The desire to sell their harvest to agricultural organizations is even more pronounced in Napo. This result does not come as a surprise, as most respondents in this region are members of such an organization, namely the Kichwa Kallari Association. This organization's approach aligns with organic production, and its members are primarily artisanal farmers who adhere to the Kichwa ethnicity [111]. Nevertheless, the loyalty of cocoa farmers is susceptible to monetary incentives offered by other actors in the supply chain, such as intermediaries [22]. They are able to make timely or advanced payments, which might serve as an important factor in establishing a trustful seller-buyer relationship, but can also play a critical role in whether farmers adopt a new production system or not [22]. For example, when intermediaries condition immediate or advanced payments on specific production practices, farmers may be encouraged to adopting these practices, deviating from the agricultural organization's advice. This is further supported by Higuchi et al. (2010), who mentioned that some intermediaries just focus on the price and neglect differences in the quality of the cocoa beans [112], for instance, from organic production [22]. In addition, intermediaries pass on transaction and further production costs, as for transport, drying etc., to the farmers, and penalize them by reducing the weight and price of the harvest. In response to such developments, the Ecuadorian government explores new strategies to improve the commercialization of the agricultural products. To illustrate, the *Unidad Nacional de Almacenamiento* (UNA, National Storage Unit) in Ecuador, a public institution, purchased the quinoa production of farmers in Cotopaxi [113]. However, shortcomings in the administrative, financial, and negotiation processes resulted in the production being stored in silos, i.e., large storage containers used to hold bulk products like grains, for extended periods. Currently, UNA has suspended its activities due to administrative management problems. Although this strategy, where the government took a direct part in the commercialization, was not successful, there are other initiatives, such as *"Rueda de Negocios"* ('Business Roundtable') [114], promoted by the Ministry of Agriculture, which brings together producers and enterprises to strengthen a more direct commercialization.

Even though preferences in favor of agricultural organizations are present in both regions, the actual decision of cocoa farmers is driven by their economic situation. Instead of directly appearing as a public actor in the commercialization channel, the government's role could be to provide support and higher priority to agricultural organizations and cooperatives in the study regions. Agricultural organizations need to be well-equipped with qualified, reliable personnel who is capable of forging a mutually beneficial agreement with all stakeholders in the chain. It is advisable to move beyond the conventional approach of solely supporting private enterprises to achieve economic growth. This narrow perspective has proven to be ineffective in addressing the complex challenges of poverty, inequality, and precarity at multiple levels, specifically in regions like Guayas and Napo [115].

#### *4.1.5. Additional payment*

Lastly, the preference for monetary compensation in Napo indicates a desire among cocoa farmers of a price premium for accepting changes, e.g., in their production systems or commercialization channels. These preferences seem to be more pronounced in the Napo region and reflect the varying contexts and disparate economic realities and expectations in Guayas and Napo provinces. The complexity of commercializing and participating in the cocoa supply chain poses a significant challenge often due to the dominance of large-scale traders and distributors [22].

### *4.2. The influence of deliberative workshops on cocoa farmers' preferences*

Our study presents a novel approach to determine farmers' preferences on cocoa production and cocoa commercialization by conducting a two-step choice experiment, including a deliberative workshop. The combined approach illuminates the intricate complexities of cocoa production systems. While deliberation processes are generally intended to foster informed decision-making, encourage a mutual communication and enhance awareness on matters of a common concern [116], our goal was to broaden farmers' understanding of production and commercialization systems. The deliberative workshops in both regions fostered openness among cocoa farmers, aiming to make them feel comfortable sharing their opinions with the table hosts, who lead the discussions. Our findings show that farmer preferences, shaped by their economic and social context, show a remarkable degree of stability. This aligns with Brouwer et al. (2017), who found that individuals can have well-defined and stable preferences [32].

#### *4.2.1. Production systems*

Our findings reveal a diverse range of preferences among cocoa farmers regarding the adoption of specific production systems. Despite the provision of institutional support, technical assistance, and price premiums for organic cocoa, the successful adoption of these systems in the long term depends on a complex interplay of social, economic, demographic, and environmental factors [8–14]. For instance, Kallari in Napo supports organic production processes [111]; however, the long-term adoption depends also on natural and social endowments, encompassing farmers' preferences [13,117].

Expecting farmers to initiate or maintain organic production systems needs substantial economic support to enable them to undertake the required additional efforts and investments. Several factors hinder this transition, often leading to net revenue losses [118,119]: significant labor requirements, low price premiums for organic products, and high certification costs [120]. The transition from conventional to organic production is also region-specific and often tailored to individual farmers, as it depends on local climate conditions, soil types, and pest challenges [121,122]. It is overly simplistic to assume that high global demand for chocolate will ensure fair compensation for farmers engaged in organic cocoa production [123]. Some consumers from the Global North frequently prefer supporting local farms and small-scale food producers, certified for instance by the Rainforest Alliance or Fairtrade label [124]. However, it is important to highlight that – for now - this remains a niche demand in Europe, where many households cannot afford organic or fair-traded products [125,126]. Additionally, the socioeconomic impact of these certifications is often context-specific, and farmers may not experience significant improvements in their income [127]. Cocoa production reflects broader economic challenges, where farmers often do not receive an appropriate compensation for their work [128]. Therefore, consumers' choice of certified chocolate is more a matter of taste than a guarantee for improved livelihoods for farmers, while for farmers, selecting a production system is often a matter of economic survival [21]. The complexities of the value chain must be carefully considered, especially when assuming that market demand alone can generate equitable outcomes for farmers [21]. Therefore, despite the potential of organic production and the respective certification to contribute to sustainable food production [129–131], ongoing socioeconomic constraints often compel farmers to adhere to conventional systems [119,132]. In our case, the deliberative workshops held with cocoa farmers may not lead them to change or reconsider their production systems. Transformative processes, particularly in agricultural contexts are slow and shaped by long-term established practices. In fact, hearing fellow cocoa farmers' perspectives might reinforce their existing preferences considering that they are living the same context. Our experiment does not encounter issues of preference inconsistency, as seen in other studies [133]. Cocoa farmers maintain remarkably stable preferences in their choice of production systems before and after the deliberative workshops.

#### 4.2.2. Microclimate

Cocoa farmers in both regions have shown a significant preference for monoculture cocoa. For instance, during a workshop one farmer in Guayas expressed that, *"fruit trees sometimes give too much shade and reduce cocoa production"*, and *"having only cocoa trees (…) prevents other trees from attracting squirrels that damage the cocoa"*. Thus, farmers tend to prioritize the yields of cocoa trees over the microclimatic effects of the shade from other trees. Therefore, although the integration of fruit and wood trees with cocoa trees is often promoted for its benefits in enhancing biodiversity, reducing monoculture risks, and generating additional income [50,134,135], this approach may not be universally beneficial. It is crucial to acknowledge that viewing such an integration solely as a poverty reduction strategy can be misleading, as evidenced by initiatives like the Plan de Reactivación del Cacao Nacional Fino de Aroma (National Fine Flavour Cocoa Reactivation Plan) [136]. The realities of individual and structural poverty frequently constrain farmers' capacity to increase income through diversified production [136]. Therefore, cocoa farmers' preferences are shaped by the specific social and economic conditions of each region [137].

#### 4.2.3. Recommendations

Recommendations for improving cocoa production were also dealt with in the deliberative workshops. They fostered mutual communication among farmers and emphasized the importance of technical knowledge. These discussions revealed that, despite cocoa farmers' deep ties to their communities and fellow farmers, they prefer to base their decisions on specialized expertise from the government. For example, a farmer stated to prefer *"… agronomists because they know more about cocoa"*, and another emphasized, *"it is important to receive advice from a technical assistant to maintain the plantation"*. Piñeiro et al. (2020) and Foguesatto et al. (2020) emphasize the crucial role of technical assistance and extension services in facilitating high adoption rates of SAPs [12,28]. However, in Ecuador, technical assistance from the government often fails in supporting productions systems aligned with SAPs. For instance, promoting conventional agricultural kits composed of modified cocoa seeds does not align with the conservation objectives outlined in the country's legislative framework nor sustainable practices [13,14,138]. This shortfall is primarily due to entrenched institutional and historical patterns prioritizing chemical inputs and mechanization over more sustainable approaches [14]. The literature predominantly addresses the effects of pesticide residues on chocolate quality and consumers' safety [51], leaving aside the health risks of farmers directly handling these agrochemicals, while complying with minimal regulatory standards [59]. While farmers often trust government advice, this relationship can have advantages and disadvantages. Trust can drive positive change towards more sustainable practices. However, it also highlights the urgent need for governmental institutions to act responsibly, value farmers' knowledge and know-how, and implement transparent, integrated policies that benefits all actors in the supply chain, with farmers recognized as key stakeholders. The success of agricultural policies depends on maintaining this trust and fostering collaboration that values farmers' insights and addresses their concrete daily challenges.

Cocoa farmers showed a clear preference for acquiring more technical knowledge related to their agricultural practices. However, our findings from the CE and the deliberative workshop indicate that the situation is more complex than generally thought. Even with the abundance of scientific expertise and direct engagement of researchers, farmers in Napo reject receiving recommendations from scientists. This points to a more general criticism of the conventional application of science focusing on technical solutions that often overlook the complex social, economic, and environmental dependencies, calling for more context-sensitive and integrated approaches [139]. This is particularly important in the countries of the Global South, where standard approaches may only partially account for local contexts' complexities and specific needs. To provide optimal conditions for the co-creation of knowledge and to achieve sustainable outcomes for cocoa producers and consumers; where both sides participate in shaping what sustainable agriculture should look like, it is recommended to engage not only researchers and local partnerships but also international NGOs and governmental policymakers. This comprehensive collaboration facilitates the integration and communication of diverse perspectives, thereby increasing the effectiveness of efforts and the potential for meaningful change [136]. However, it is important to recognize that while improving farmers' knowledge through technical assistance is crucial, its application and impact finally depends on the preferences and constraints of the farmers themselves. Furthermore, the absence of applied research in numerous scientific projects gives rise to concerns, as the conventional application of methods without considering the specific context might lead to the phenomenon of "helicopter research" [108,109].

#### 4.2.4. Commercialization channels

While private enterprises and agricultural organizations were significantly preferred in both regions before the deliberative workshop, these preferences turned out to be insignificant afterwards, except for public institutions in Napo. During the discussion, cocoa farmers articulated their perceptions of the various limitations and constraints they encountered with respect to agricultural organizations. Despite the deliberation in Napo where farmers expressed loyalty to Kallari, with one stating, *"I sell to Kallari … I like it, and I am used to it; there is no other institution"*, it is important to emphasize once again that farmers are primarily driven by economic reasoning and constraints of their livelihoods. While agricultural organizations like Kallari may be the best option for supporting social and community efforts, market competitors like intermediaries hold an institutional advantage that allows them to attract more cocoa farmers in both regions.

At the discussion tables in Guayas, a farmer highlighted the immediate payment provided by intermediaries, noting it as a significant advantage: *"intermediaries … pay directly on the same day of sale"*. During the COVID pandemic, intermediaries – based on their economic power - were able to mobilize financial resources to collect cocoa production in areas such as Guayas [140]. Under these circumstances, farmers are less likely to favor agricultural organizations, as the supply chain continues to be dominated by those who have traditionally controlled the commercialization of cocoa [22]. This is evident in the study by Rasyidin et al. (2024), who found that the majority of cocoa farmers continue to sell to intermediaries [141]. Supporting these existing channels [140], as suggested by Zambrano et al. (2024), may further entrench the position of these dominant players and sideline efforts to strengthen agricultural organizations. Excluding the intermediaries from the market would not be a viable option, given their integral role in the global food system [142]. However, fostering collaboration and enhancing transparency are essential steps toward addressing cocoa farmers' endeavor to improve their position as producers in the supply chain. A more collaborative approach between agricultural organizations and the private sector is needed to promote a more an equitable and fair supply chain. Initiatives such as the Rueda de Negocios [114] seem promising by facilitating direct and fair trade between producers and private companies. However, the success of such initiatives depends on ensuring that they do not simply reinforce existing power dynamics but truly empower cocoa farmers within the supply chain.

#### 4.2.5. Additional payment

In both regions, the stated preferences for a monetary compensation became stronger after the deliberative workshops. Nevertheless, there is no assurance that (i) conventional farmers will switch to natural or organic systems or that (ii) those currently engaged in organic production will persist in this practice. It is crucial that the additional costs of this production type are appropriately compensated throughout the supply chain. A major obstacle for achieving this goal is the high volatility of global cocoa prices [143]. Cocoa farmers are highly susceptible to these fluctuations, and short-term changes in their specific socio-economic circumstances can significantly impact their ability to cope with these challenges. Consequently, ensuring stable and fair conditions for organic cocoa production and marketing is crucial for successfully promoting its adoption. How the suggested price premium could be successfully implemented in practice is subject to discussion [127], but was not the focus of our study.

### 4.3. Limitations

#### 4.3.1. Hypothetical and social desirability bias

In the CE, the cocoa farmers were faced with hypothetical scenarios to envision different production and trading systems. The hypothetical nature of the scenarios presented may introduce bias in respondents' choices, primarily due to the absence of real-world commitments or consequentiality associated with their decisions. Despite these challenges, it is important to emphasize that choice experiments remain a valuable tool in understanding individuals' preferences and decision-making. While it is widely acknowledged that no technique can entirely eliminate hypothetical bias [55], we have addressed this issue by applying various strategies to mitigate its effects in our choice experiments, like the inclusion of a cheap talk, the opt-out alternative, socialization of the research project and choice experiment, and careful scenario design [84,144]. While Hensher (2010) suggested the inclusion of supplementary questions to gain deeper insights [144], a possible drawback of extending surveys in this way could be participant fatigue and cognitive overload [145].

Social desirability refers to a presumed tendency of individuals to provide socially acceptable responses rather than to state their actual preferences. Particularly in personal interviews, social desirability might occur, when respondents choose answers to please the interviewer [146]. Andersen and Mayerl (2017) recommend applying randomized response techniques to mitigate this type of bias [147]. Choice experiments use such approaches, when designing the combinations of attribute levels in the different choice sets. While a recent meta-analyses indicates that social desirability tends to be less pronounced in studies on environmentally relevant behavior, its effect are known to vary by context [148]. As mentioned before, a cheap talk was introduced as a strategy to reduce hypothetical bias, but as well serves to encourage honest responses and to reduce social pressure. Therefore, our use of cheap talk was a deliberate and well-considered choice to enhance the credibility of the stated preference data. In line with Huls et al. (2023), who highlight the value of carefully designed scripts that help reduce social desirability bias by encouraging honest and unconstrained responses [149], all table hosts introduced the cheap talk before the choice experiment. The hosts focused on delivering the message clearly and relatable, fostering open dialogue, and prompting farmers to reflect on the choices they would realistically make in their everyday lives.

#### 4.3.2. Choice experiment and deliberative workshop setup

In the CE setup, we built groups of 7–8 farmers and gathered them around tables. Despite instructions not to share opinions during the first choice experiment, some farmers voiced their preferences, potentially influencing the decisions of other participants. This setup might have influenced some farmers to provide survey answers that align with their table neighbors. Further, it was emphasized that the CE exercise had to be done individually. Nevertheless, sometimes farmers needed assistance from the table hosts or other farmers due to language differences or challenges with reading, writing and communication.

To enrich the diversity of perspectives during the deliberative phase, a randomized seating strategy was implemented for the round tables. This approach was chosen to separate farmers from their familiar associates, thereby encouraging interactions with a broader range of participants and potentially eliciting more diverse viewpoints. However, it is essential to recognize that this randomization technique may unintentionally lead to resistance to participate among some farmers, who may feel uncomfortable or hesitant when separated from their usual network [145]. Future studies could investigate adaptive randomization strategies taking the respective pros and cons into account, thereby potentially enhancing both the farmers' active participation and the data quality.

#### 4.3.3. Impact of deliberation

The deliberative workshop was conducted to discuss each CE attribute in detail assuming a possible impact on farmers' preferences. However, we found that the preferences of the farmers participating in the CE before and after a deliberative workshop seemed to be rather stable. Given the duration of the deliberation workshop of only about one hour, the provided time to participate in the discussion as well as to rethink and further develop farmers' preferences was relatively short. The timeframe chosen for the workshop was influenced by the need to accommodate farmers' daily work and responsibilities, compounded by a general state of emergency declared by the Ecuadorian government during the time of fieldwork. Notwithstanding the prevailing fear and the political challenges at the national level, the farmers demonstrated interest and commitment in opting to participate in the workshop.

While the duration of the deliberation is considered to be important, opinions vary on its optimal length [133,150]. Longer deliberation activities may enhance preference development [12], but they can paradoxically reduce preference consistency [133]. Our study employed a time-constrained approach with a structured guideline to facilitate discussions, aiming to minimize external influence on farmers' conversations.

#### 4.3.4. Social norms

Farmers' preferences could be affected by social influence from their neighbors, relatives [151,152], and, in our case, from the members of the agricultural organization in which they participate. Thoughts, feelings, attitudes, or behaviors can change due to interaction with other individuals or groups [153]. In Global South countries, farmers often participate in social networks such as agricultural organizations and irrigation boards. These networks are built on solid trust ties to achieve common objectives that benefit all members. Here, social norms play a significant role in influencing the behavior considered appropriate within farming communities [154,155]. In particular, injunctive norms, which refer to the perceived expectations of others, may influence farmers' actions during deliberative workshops [156]. Additionally, subjective norms, which reflect an individual's personal perception of what is normal behavior, can also affect farmers' actions and decisions [157]. Researchers should strive to create an environment that fosters open discussion without judgment, ensuring a safe space where farmers feel comfortable sharing their daily perspectives and challenges.

## 5. Conclusions

Achieving sustainable practices in agriculture is an ambitious goal, requiring consideration of not only environmental aspects but also social, economic principles, and cultural sensitivity. The adoption of SAPs exceeds factors linked solely to the farmers' side. It requires structural transformative processes and systemic change across the entire supply chain - from producers to consumers. Combining a two-step CE with deliberative workshops generated valuable insights into cocoa farmers' preferences on production systems, microclimate, recommendations, and commercialization channels within the cocoa supply chain. Our study reveals that while creating a space for deliberation may not have directly altered cocoa farmers' preferences, it provided an essential space for knowledge exchange, social connection, and trust-building.

For farmers to successfully adopt SAPs, technical extension services are crucial, but they should be reinforced by governmental commitments to economic, social and environmental foundations that are both declared as well as rigorously practiced and upheld. The persistent gap between research and practice highlights the need to involve local researchers and stakeholders, who can induce more meaningful changes in real-world settings beyond academic discourse. While intermediaries play a significant role in the cocoa value chain, merely empowering them further will not necessarily lead to systemic improvements. Instead, national public policy should strengthen agricultural organizations and fostering their leadership capacities.

Ultimately, the question arises, to what extent the transition to more sustainable production systems can be achieved if the focus remains solely on the environment while social aspects are overlooked. At this point, real and fair transformations necessitate both individual and institutional commitments from all stakeholders within the supply chain, encompassing not only the production side in the Global South but also the consumption side in the Global North, with trading laws ensuring equity. This shift requires moving beyond the 'warm-glow giving' of consumers when choosing chocolates labeled as fair traded or environmental-friendly produced, and instead focusing on tangible support for cocoa farmers, for whom sustainability is often not a question of taste but a necessity for economic survival.

## CRediT authorship contribution statement

**Maritza Satama-Bermeo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Laura García-Espigares:** Investigation. **Léa Lamotte:** Investigation. **Karen Ramírez:** Investigation. **Adriana Santos:** Investigation. **Guillermo Zambrano:** Investigation. **Roland Olschewski:** Writing – review & editing, Supervision, Funding acquisition.

## Funding

The research was supported by a grant from the Swiss National Science Foundation (SNSF) Sinergia Programme (grant number CRSII5_202300).

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

The research team would like to thank all the farmers who participated in this study. We would also like to thank Israel Jiménez and Ana Alarcón, Ecuadorian field technicians, for their help in organizing and carrying out the fieldwork. We would like to thank Max Rudolf for his very insightful comments, which strengthened the manuscript.

## Data availability

Data will be made available on request.

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