# Socio-technical-economic characterization of cocoa production systems in the Manabí province micro-regions - Ecuador

Caracterización socio-técnica-productiva de los sistemas de producción de cacao en las microrregiones de la provincia de Manabí – Ecuador

Caracterização sociotécnico-econômica dos sistemas de produção de cacau nas microrregiões da província de Manabí – Equador

Saskia Valeria Guillén Mendoza[1*]
Fátima Urdaneta[2]
Elvis Portillo[3]

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[1]Escuela Superior Politécnica Agropecuaria de Manabí "Manuel Félix López" (ESPAM MFL). Calceta, 10 de Agosto #82 y Granda Centeno. Calceta, Manabí, Ecuador.
[2]Departamento de Ciencias Sociales y Económicas, Facultad de Agronomía, LUZ. Avenida Guajira, Ciudad Universitaria, Núcleo Agropecuario, Facultad de Agronomía. Apartado 15205. Maracaibo, edo. Zulia 4001, Venezuela.
[3]Departamento de Agronomía, Facultad de Agronomía, LUZ. Avenida Guajira, Ciudad Universitaria, Núcleo Agropecuario, Facultad de Agronomía. Apartado 15205. Maracaibo, edo. Zulia 4001, Venezuela.

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## Abstract

Cocoa production systems vary depending on regional conditions and agronomic and post-harvest management practices that impact cocoa quality. This descriptive study was conducted to characterize the cocoa production systems of the microregions of Manabí Province, Ecuador, in their social, technical, and productive dimensions. This study is important because it allows us to understand the differential characteristics of cocoa production systems in Manabí, facilitating decision-making to improve the productivity and quality of Ecuadorian cocoa, a strategic product for the national economy. To this end, a sample of 150 producers was taken from the Northern, Central, and Southern regions of Manabí, who were then administered a questionnaire. Cross-tabs were compiled across regions with the frequencies or means of the calculated indicators, and $X^2$ tests or analysis of variance (depending on the type of variable) were applied. Results allowed for the identification of characteristics specific to each microregion; however, the producers in the South stood out with higher productivity and average income, since they are directly dedicated to cultivation, work on mostly legally registered properties, planted mainly with "Nacional" cocoa, which is propagated by seed, and despite watering and recording very little; they stand out for carrying out the entire post-harvest process, a determining factor in the best productive outputs since they obtained the best price related to the quality of their cocoa.

*Corresponding author: saskyaguillem@gmail.com

## Resumen

Los sistemas de producción de cacao presentan diferencia en distintas condiciones regionales, así como por diversos manejos agronómicos y postcosecha que inciden en la calidad del cacao producido. Se realizó esta investigación descriptiva con el objetivo de caracterizar los sistemas de producción de cacao de las microrregiones de la provincia de Manabí, Ecuador, en sus dimensiones social, técnica y productiva. Este estudio es importante porque permite comprender las características diferenciales de los sistemas productivos de cacao en Manabí, lo que facilita la toma de decisiones para mejorar la productividad y calidad del cacao ecuatoriano, un producto estratégico para la economía nacional. Para ello, se tomó una muestra de 150 productores en las regiones Norte, Centro y Sur de Manabí a quienes se les aplicó un cuestionario. Se realizaron tablas cruzadas de las regiones con las frecuencias o medias de los indicadores calculados y se aplicaron pruebas de $X^2$ o Análisis de varianza (dependiendo del tipo de variable). Los resultados permitieron identificar características propias de cada microrregión; sin embargo, se destacaron los productores del Sur con mayores productividades e ingresos medios, ya que están dedicados directamente al cultivo, trabajan en predios en su mayoría legalizados, sembrados principalmente de cacao Nacional, el cual es propagado por semilla; y apesar que riegan poco y llevan pocos registros del proceso productivo; se destacan por realizar todo el proceso postcosecha, factor determinante en las mejores salidas productivas ya que obtuvieron el mejor precio relacionado con la calidad de su cacao.

**Palabras clave:** postcosecha, manejo agronómico, productividad, cacao Nacional

## Resumo

Os sistemas de produção de cacau variam dependendo das condições regionais, bem como das práticas de manejo agronômico e pós-colheita que afetam a qualidade do cacau produzido. Esta pesquisa descritiva foi realizada para caracterizar os sistemas de produção de cacau das microrregiões da província de Manabí, Equador, em suas dimensões social, técnica e produtiva. Este estudo é importante porque proporciona uma compreensão das características distintivas dos sistemas de produção de cacau em Manabí, facilitando a tomada de decisões para melhorar a produtividade e a qualidade do cacau equatoriano, um produto estratégico para a economia nacional. Para tanto, foi realizada uma amostra de 150 produtores das regiões norte, centro e sul de Manabí, aos quais foi aplicado um questionário. Foram feitas tabulações cruzadas das regiões com as frequências ou médias dos indicadores calculados e aplicados testes $X^2$ ou Análise de Variância (dependendo do tipo de variável). Os resultados permitiram identificar características específicas de cada microrregião; no entanto, os produtores do Sul destacaram-se pela maior produtividade e renda média, uma vez que se dedicam diretamente ao cultivo, trabalham em propriedades maioritariamente legalmente registradas, plantadas principalmente com cacau Nacional, propagado por semente; utilizam também irrigação, mas mantêm poucos registros do processo produtivo; destacam-se por realizarem todo o processo pós-colheita, fator determinante para os melhores resultados produtivos, visto que obtiveram o melhor preço relacionado à qualidade do seu cacau.

**Palavras-chave:** pós-colheita, gestão agronómica, produtividade, cacau Nacional

## Introduction

In Manabí, a province of Ecuador, cocoa is a representative product of several cantones (municipalities). Its production has been a source of income for many families for years (Freire, 2018). There are 130,924 hectares planted with an approximate production of 45,000 tons (INEC, 2022), which is marketed through intermediaries. This cocoa has not undergone a correct post-harvest process, which is why its fermentation levels are very low, presenting wide variations in its characteristics (Palacios *et al.,* 2021).

Productivity of cocoa plantations is influenced by a complex interaction of social variables, crop management and post-harvest practices, however, these factors have not been fully integrated, maintaining the perception that performance depends exclusively on genetic material, underestimating the decisive influence of socioeconomic factors, specific agronomic techniques and post-harvest processes in productive optimization (Barrezueta & Chabla, 2017).

This varied combination and interaction of causes has not been studied comprehensively, justifying the need to perform analyses with a systemic approach. Several authors (Coronel & Ortuño, 2005; Ordoñez *et al.*, 2019; Solano *et al*., 2000) provide a very useful comprehensive vision to address this type of research and thus be able to establish the influence of the different decisive processes on the final product, given that interest in chocolate has increased due to its functional and potential health effects, so each production system must be managed with well-defined criteria and objectives (Abt & Robin, 2020).

Platas *et al.* (2017) define production systems as an ecosystem modified by humans through the use of natural resources in agricultural production processes, valuing the role of producers as decision-makers in their management practices, thus ratifying the need to consider the role of humans for their study and comprehensive understanding.

In this way, at least the social, technical, and productive dimensions emerge for the study of production systems, the first related to man, his potential as a producer and his role as decision-maker; the second to all aspects of agronomic and post-harvest management; and the third to the productive outputs of the system.

Thus, a descriptive research was proposed with the objective of characterizing the cocoa production systems of the province of Manabí, in their social, technical and productive dimensions.

## Materials and methods

The research was conducted using a non-experimental, field-based design (Arias, 2006) and comparative type (Hurtado, 2010), given that differences in the characteristics of the microregions will be established.

**Study area geographic location**

Field research was carried out in the province of Manabí, located at the center-northwest of Ecuador, which has a subtropical climate between dry and humid, as well as a temperature average of 24 °C, a relative humidity of 83.3 % per month and a rainfall average of 2,100 mm.year$^{-1}$. (Gobierno Provincial de Manabí, 2021).

**Population and sample**

The study universe consisted of the cocoa production systems in the province of Manabí. The sample was selected through stratified random sampling with proportional allocation (Scheaffer *et al.*,

1987). The strata were determined by the different cocoa production zones in the province, taking into account the importance by planted area. The Northern microregion has the highest percentage of cocoa area (63.13 %), followed by the Central region (27.77 %), and the Southern region has the lowest percentage (9.10 %) (Ministry of Agriculture and Livestock, 2021). Sample was established with this in mind (Table 1).

**Table 1. Distribution of the sample by microregion and cantones (municipalities).**

| Microregion (strata) | N | N | Sample % |
|---|---|---|---|
| North (Chone, El Carmen y Pedernales) | 610 | 60 | 40,00 |
| Center (Bolívar y Pichincha) | 577 | 59 | 39,33 |
| South (Portoviejo, Santa Ana, Pajan y 24 de Mayo) | 394 | 31 | 20,66 |
| | 158 | 150 | 100 |

**Data collection technique and instrument**

A socio-technical-productive questionnaire was designed as a data collection instrument, administered individually to the sampled producers. It consisted of closed-ended questions that responded to the theoretical construct that allowed the study variable systematization. Its indicators are:

Social dimension: gender, educational level, occupation, whether engaged in another productive activity, living on the plot, land ownership, public services, type of road, road conditions, associate, technical assistance, financing, labor, records, soil analysis, water analysis.

Technical dimension: agronomic management sub-dimension: type of cocoa, farm area, plantation age, planting density, propagation type, shade type, crop planting system, fertilizer, type of fertilization, pruning, irrigation, type of irrigation, water source, pest and disease control, weed control.

Post-harvest management sub-dimension: fermentation method and days, removal and frequency, drying and duration of days, humidity, storage time.

Productive dimension: marketing, sales price, cocoa processing, cocoa planted area, production, cocoa sales revenue, yields.

**Data processing and analysis**

Descriptive statistics, frequencies for discrete variables, and means and standard deviations for continuous variables were calculated. Contingency tables were constructed to compare the behavior of the microregions. $X^2$ was applied to identify the relationship between the discrete indicator and the groups (microregions). Analysis of variance was also performed for continuous variables. The analyses were conducted using SPSS v21.

## Results y discussion

**Social Dimension**

The producers average age was 55.0±14.7 years, 88.7 % of whom were male; 67.3 % had a primary education, and 78.7 % had agriculture as their primary activity; however, 54 % reported another productive activity to supplement their income. 74 % lived on the farm or production unit., 47.3 % of these producers received technical assistance, which generally came from government institutions. In addition, 28 % had access to credit (Table 2).

$X^2$ test showed an association between the indicators of farmer occupation, other productive activity, technical assistance, associativity, and legalization of the plot with respect to the microregions ($pX^2 \leq 0.01$), meaning that they behave differently among them. Data shows that in the Southern microregion, fewer farmers are dedicated to this crop and other occupations were eported in the survey as housewives and students. They also show the highest percentage of plot legalization with legal security for production.

**Table 2. Indicators of the socio-managerial dimension**

| Indicator | Microregion (% by Microregion) | | | Total |
|---|---|---|---|---|
| | North (N=60) | Center (N=59) | South (N=31) | (%) (N=150) |
| Age in years* (mean±sd) | 50.7±15.8 | 59.7±13.5 | 54.4±11.7 | 55.0±14.7 |
| Male Gender | 86.7 | 93.2 | 83.9 | 88.7 |
| Primary education level | 60.0 | 72.9 | 71.9 | 67.3 |
| Occupation: farmer * | 83.3 | 83.1 | 61.3 | 78.7 |
| Other productive activity** | 41.7 | 69.1 | 48.4 | 54.0 |
| Lives on the plot | 73.3 | 72.9 | 77.4 | 74.0 |
| Technical assistance** | 31.7 | 59.3 | 54.8 | 47.3 |
| Finnancial support | 21.7 | 32.2 | 32.3 | 28.0 |
| Asociated** | 68.3 | 89.8 | 64.5 | 76.0 |
| Legalized property** | 76.7 | 94.9 | 96.8 | 88.0 |

**P $X^2 \leq 0.01$; *P $X^2 \leq 0.05$; mean ± sd: mean ± standar desviation

In terms of technical assistance, it is striking that the Northern microregion has the least access to it. In this sense, Paladines *et al*. (2022) highlight the importance of receiving technical assistance, as there are different factors that can negatively affect crop production, especially in small production units where management is inadequate. The Central microregion has the highest frequencies in other productive activities and associativity, which could be due to the agricultural academic offering of a university located in this area, in addition to generating sources of work.

Regarding public services, it was observed that electricity service was available in 100 % of the production units, drinking water service was available in 61.3 %, 24 % had internet access and 34 % had available a health center in their community (Table 3). 60.7 % of producers access their farms via dirt roads, but 72.1 % considered the road system acceptable. The availability of public services is essential for the good performance of farmers and the subsequent development of agricultural activities, as mentioned by Martínez (2023) in his classification of cocoa producers in Córdoba, Colombia, who indicates, that access to electricity facilitated the acquisition of equipment that increased crop production. The $X^2$ test did not detect any behavior in the indicators associated with the microregions, since, in most cases, the observed frequencies were very low.

**Table 3. Public service indicators (Socio-managerial Dimension)**

| Indicator | Microregion (% by Microregion) | | | |
|---|---|---|---|---|
| | North (N=60) | Center (N=59) | South (N=31) | Total % (N=150) |
| Drinking wáter service | 60.0 | 78.0 | 32.3 | 61.3 |
| Internet | 28.3 | 27.1 | 9.7 | 24.0 |
| Health center | 38.3 | 35.6 | 22.6 | 34.0 |
| Cable | 33.3 | 15.3 | 9.7 | 21.3 |
| Access by dirt road | 46.7 | 59.3 | 90.3 | 60.7 |
| Aceptable road system | 65.0 | 72.9 | 83.9 | 72.1 |

Table 4 shows a series of indicators that attempt to characterize the management carried out by the cocoa producer. Although management theory is very complex (Ropa and Alama, 2022), the detection of indicators in these systems is very basic given that most producers do not keep records; only 42 % do so manually; very few carry out soil (7.3 %) and water (4.7 %) analysis, so that decision-making regarding irrigation, fertilization, and other practices is very empirical; furthermore, the predominant workforce is family labor, as only 42 % hire any staff. Both hiring labor and keeping administrative records were associated with microregion ($X^2 \leq 0.001$). While a greater number of producers are engaged in another activity, they need to hire labor, besides record-keeping was a predominant activity in the central microregion with the highest level of associativity, as shown in Table 2.

**Table 4. Management indicators (Socio-managerial dimension)**

| Indicator | Region (% by region) North (N=60) | Center (N=59) | South (N=31) | Total (Total %) (N=150) |
|---|---|---|---|---|
| Hire labor* | 56.7 | 47.5 | 29.0 | 47.3 |
| Keep manual records** | 31.7 | 67.8 | 12.9 | 42.0 |
| Perform soil analysis | 3.3 | 13.6 | 3.12 | 7.3 |
| Perform water analysis | 5.0 | 3.4 | 6.5 | 4.7 |

**p$X^2$ ≤0,01; *p $X^2$ ≤0,05

**Technical dimension**

**Agronomic management sub-dimension**

In the province of Manabí, 82.6 % of producers cultivated only Nacional cocoa type (Table 5) plus a 14.8 % which also presented CCN-51 cocoa (Castro Naranjal Complex), only 2.7 % of the productive systems are dedicated to the exclusive cultivation of CCN-51; although Anzules *et al*. (2022) reported that CCN-51 occupies 50% of the cultivated area representing 80 % of Ecuador's exportable production. Iin Manabí, the cultivation of Nacional type prevails, which means a strength in the production of aromatic species with a better price.

**Tabla 5. Manabí Cocoa Types**

| Cocoa type | Microregion (% by Microregion) North (N=60) | Center (N=59) | South (N=31) | (Total %) (n=150) |
|---|---|---|---|---|
| Nacional | 76.7 | 86.2 | 87.1 | 82.6 |
| CCN | 3.3 | 0.0 | 6.5 | 2.7 |
| Both types | 20 | 13.8 | 6.5 | 14.8 |

Table 6 shows the characteristics of the property and the crop, including the average surface area of the production units, which was 8.1±13.6 ha, and whose plantations have an average of 17.2±14.20 years of age with a planting density of 836±251 plants.ha$^{-1}$. In relation to agronomic management, it was observed that 56.7 % carried out propagation by seeds and 38.0 % by grafting, propagation by twigs is is rarely used. Cocoa cultivation was planted in association (74.7 %) with other crops such as citrus (38.7 %) and timber (26.7 %) mainly.

Producers reported that 45.3 % irrigated their plantations using flood irrigation. 38 % used fertilizers; of that total, 55.4 % applied organic fertilizer once a year. Among the most frequently performed management practices were weed control and pruning. Pruning was once a year (76.9 %), weed control was manual (86.9 %) and mechanical (9 %). Pest and disease control was carried out by 63 % of farmers.

There was an association between regions ($pX^2 \leq 0.01$) and propagation, irrigation, fertilization, and pruning, as well as with farm size ($p \leq 0.05$). These practices are most commonly performed in the central region, on smaller farms, allowing for greater control over activities. This could be due to the fact that these farmers are associated and receive training on management practices.

**Table 6. Technical dimension indicators**

| Indicator | Microregion (% by Microregión) North (N=60) | Center (N=59) | South (N=31) | Total % (n=150) |
|---|---|---|---|---|
| Farm area* (mean±sd) | 8.8±12.4 | 4.7±8.1 | 13.5±20.8 | 8.1±13.6 |
| Plantation age (years) (mean±sd) | 15.6±14.4 | 16.8±13.6 | 21.0±19.9 | 17.2±14.20 |
| Density (plants.ha-1) (mean±sd) | 892±221 | 814±291 | 771±205 | 836±251 |
| Seed propagation** | 28.3 | 71.2 | 83.9 | 56.7 |
| Graft propagation** | 65.0 | 22.0 | 16.1 | 38.0 |
| Associated crop | 68.3 | 79.7 | 77.4 | 74.7 |
| Permanent shade | 68.3 | 59.3 | 83.9 | 68.0 |
| Irrigation** | 41.7 | 69.5 | 6.5 | 45.3 |
| Fertilization* | 36.7 | 47.5 | 22.6 | 38.0 |
| Pruning** | 63.13 | 88.1 | 87.1 | 78.0 |
| Weed control | 100 | 94.0 | 93.5 | 96.7 |
| Pest control | 66.7 | 62.7 | 58.1 | 63.3 |

**p $X^2$ ≤0.01; *p $X^2$ ≤0.05; mean ± sd: mean ± standar desviation

**Postharvest sub dimension**

Table 7 shows that 36 % of the cocoa almonds were fermented, 87 % were fermented in sacks, and the fermentation lasted 2 to 3 days (46 % and 31 %). 51.6 % of the producers who fermented, removed the ferment 12 hours after fermentation start. Drying was carried out in 39.3 % of cases, lasting 2 to 3 days (71 %), depending on weather conditions. The most common method for this activity was the "tendal" that is exposing the cocoa beans to the sun on raised platforms (58.9 %) followed by canopies or greenhouse-like structures (25 %). Storage lasted 1 to 2 days (57.2 %). Fermentation, removal, drying and storage were associated with the microregions ($X^2 \leq 0.01$), these practices were carried out the most in the Southern region (54.8; 32.3; 61.3 and 77 % respectively) since they must occur sequentially for good cocoa almond processing (Cerón *et al*., 2020; Streule *et al*., 2023).

**Table 7. Post-harvest dimension indicators**

| Procesos postcosecha | Microregion (% by Microregión) North (N=60) | Center (N=59) | South (N=31) | (Total) % (n=150) |
|---|---|---|---|---|
| Fermentation** | 41.7 | 20.3 | 54.8 | 36.0 |
| Sacks fermentation (n=54) | 88.0 | 91.7 | 82.4 | 87.0 |
| Removal* | 23.3 | 10.2 | 32.3 | 20 |
| Removal 12 hr (n=30) | 42.9 | 71.4 | 50.8 | 51.6 |
| Drying** | 48.3 | 18.6 | 61.3 | 39.3 |
| "Tendal" drying | 58.6 | 40.0 | 70.6 | 58.9 |
| Canopy drying | 41.4 | 0 | 11.8 | 25.0 |
| Drying 2 days | 44.8 | 72.7 | 63.7 | 55.9 |
| Storage (1 to 2 days)* | 44.8 | 80.0 | 77.0 | 57.2 |

**p $X^2$ ≤0.01; *p $X^2$ ≤0.05

**Productive dimensión**

Regarding the marketing channels identified in the productive dimension (Table 8), results showed that 49.3 % of this production was taken to collection centers, 26.7 % was taken to intermediaries and 24 % to trading companies located in different zones, evidencing a total absence of direct sales to exporters. This finding coincides with Salazar and Espinoza (2022) who indicate a structural imbalance in the marketing chain that harms primary producers. This imbalance is characterized by a scenario of poor competitiveness, where a notable lack of integrated commercial strategies is evident, as well as the absence of effective monitoring and control mechanisms that could optimize profitability for producers and strengthen their negotiating position in the market.

In all microregions, there was a very little tendency to process cocoa in the same production unit, reaching only 8.11 %, preventing producers from adding value to the product and obtaining its benefitst.

**Table 8. Marketing indicators**

| Indicator | Microregion (% by Microregion) North (N=60) | Center (N=59) | South (N=31) | (%Total) (n=150) |
|---|---|---|---|---|
| Sells to intermediary* | 45.0 | 5.1 | 32.3 | 26.7 |
| Sells to Collection center* | 18.3 | 76.3 | 50.1 | 49.3 |
| Direct to retail | 36.7 | 18.6 | 9.7 | 24.0 |
| Sells slime cocoa** | 18.3 | 66.8 | 3.2 | 34.0 |
| Moisture content (media ± sd) | 5±7.1 | 47.1±34.9 | 27.9±25.4 | 32.9±30.1 |
| Price ($.q-$^{1}$)* (media ± sd) | 53.74±11.5 | 49.47±12.6 | 61.42±15.3 | 53.65±13.5 |
| Processes cocoa | 8.3 | 6.9 | 9.7 | 8.11 |

**p $X^2$ ≤0.01; *p $X^2$ ≤0.05; q: quintals; mean ± sd: mean ± standar desviation

Mendoza *et al.* (2021) indicated that the production and marketing of cocoa presents difficulties throughout the entire process, with planning and development policies being decisive in guaranteeing the social well-being of all actors in the production chain, as well as agroecological development in obtaining this agricultural good.

Table 9 shows the productive indicators, the outputs of the system, i show that the average area planted with cocoa per farm was 3.21±3.38 ha with an average production per farm of 23.31±59.02 q, which caused an income of $ 1,275.52±3,232.20 with average yields of 4.61±5.64 q.ha$^{-1}$ of cocoa (230.62±281.78 t.ha$^{-1}$), there were only significant differences for yield ($p \leq 0.05$) since the South region stood out with 850 ± 930 kg.ha$^{-1}$, being higher than the national average which is between 500-600 kg.ha$^{-1}$ (National Financial Corporation, 2021); so this is an important point to consider, since it would improve their income due to greater productivity and consequently their quality of life, in this way producer becomes more competitive in the national market.

Faced with this productive reality, several authors (García-Domínguez *et a*l., 2021; Salazar & Espinoza, 2022) agree that to overcome these performance gaps and increase the competitiveness of the Ecuadorian cocoa sector, it is necessary to implement fundamental strategies such as promoting the development of producer associations, implementing techniques that improve productivity, consolidating access channels to the international market and strengthening research aimed at genetic and agronomic improvement.

An analysis of the social, technical and productive dimensions of cocoa production systems in Manabí shows a relationship between the post-harvest processes implemented in the Southern microregion and their superior yields and prices. Furthermore, the high level of associativity in the Central Microregion correlates with greater receipt of technical assistance and the subsequent adoption of improved agronomic practices such as fertilization, irrigation, and pruning. These findings are consistent with those reported by Barrezueta and Chabla (2017), who determined that cocoa yield depends on a complex interaction of socioeconomic factors and specific agronomic techniques, beyond genetic material. Similarly, Gortaire *et al*. (2020) and Sobalbarro *et al*. (2020) have documented that farmers organization in formally registered associations and technical assistance access are determining variables for the adoption of innovations in cocoa production systems. The legalization of farms, particularly high in the South and Central microregions, is related to better access to services and credit, confirming the importance of legal security as a determining factor for investment in technological improvements in agroecological systems (Cevallos *et al*., 2019; Kassie *et al.,* 2013).

## Conclusions

Cocoa producers in Manabí are predominantly middle-aged men with primary education, who live on legalized plots and participate in associations, but have limited access to technical assistance and demonstrate a limited use of record and analysis for agricultural decision-making.

"Nacional" type cocoa prevails as the main variety, although there is an emerging presence of CCN-51, which could compromise traditional quality. Low productivity is primarily associated with insufficient irrigation, fertilization, and pruning practices. Deficiencies in post-harvest processes, especially fermentation, are a critical differentiating factor between microregions that directly impact final price and quality.

The Southern microregion is distinguished by its high yields and incomes, occupational diversification (farmers, students, and homemakers), a high degree of land properties legalization, and the full implementation of post-harvest processes that improve product

**Table 9. Productive indicators (mean ± standard deviation)**

| Region | Cocoa area (ha) | Production (q) | Income ($) | Yield.* (q.ha$^{-1}$) | Yield.* (kg.ha$^{-1}$) |
|---|---|---|---|---|---|
| South | 2.8±2.3 | 42.9±90.3 | 1.942.4±3.292.6 | 8.5±9.3 | 850±930 |
| North | 3.5±3.5 | 17.3±53.5 | 1.001.7±3.222.4 | 3.4±3.4 | 340±340 |
| Center | 3.1±3.6 | 19.0±40.0 | 1.196.2±3.218.8 | 3.7±3.7 | 370±370 |
| Total | 3.2±3.3 | 23.3±59.0 | 1.275.5±3.232.2 | 4.6±5.6 | 460±560 |

q= quintals

quality and price. There is a clear need for rural extension programs tailored to the specific characteristics of each microregion to improve production quality and farmers' decision-making capacity regarding the presentation and marketing of their products.

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