# Mexico’s Coffee Value Chain

## Insights into production costs, actual income of coffee farmers, and supply chain efficiency

ICO Coffee Public Private Taskforce (CPPTF)
Market Transparency Technical Workstream

Prepared by:
Committee on Sustainability Assessment (COSA)

# Contents

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# Executive Summary

The International Coffee Organization (ICO) collaborates with nations to strengthen the global coffee sector and promote its sustainable growth within a market-driven framework. In 2019, it launched the Coffee Public-Private Taskforce (CPPTF) to foster consensus between public and private stakeholders on priority issues and actions. This initiative aims to ensure the sustainability and fairness of the global coffee sector at both local and global levels. Through the CPPTF’s Technical Work Stream on Market Transparency (TWS II), The Committee on Sustainability Assessment (COSA) facilitated the development of methodologies and tools specifically tailored for data collection on vital topics such as coffee production costs, actual total household incomes of coffee farmers, and efficiency within the coffee supply chain.

With the support of The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), COSA, in partnership with the Secretariat of Agriculture and Rural Development (SADER) and its designated research institution, the National Institute for Forestry, Agriculture and Livestock Research (INIFAP), embarked to pilot the work of the ICO TWS II in Mexico. Since February 2023, the organizations have collaborated to refine and adapt methodologies and tools to the local Mexican context, and to execute the work. This effort is instrumental in directing targeted policy and investment initiatives in Mexico.

In Mexico there are about 545 thousand coffee farmers working on 712 thousand hectares of coffee (SIAP, 2021). However, only four states represent 85% of total coffee area, and 90% of total coffee production, namely Chiapas, Veracruz, Oaxaca and Puebla.

After the devastating effect of coffee leaf rust in Mexican productivity that nearly halved its production in 2015/16, different initiatives from SADER, AMECAFE and others have contributed to the recovery of coffee production in Mexico.[1] However, there is still significant room to improve productivity and livelihoods of coffee farmers.

This study provides significant insights on coffee production costs, household income, and value chain efficiency, which aims to tackle key socio-economic barriers for further development of the coffee value chain, in particular with respect to coffee farmers.

According to this study, Mexico's coffee farming industry faces a critical challenge as its average farmer is 54 years old. With only 11% of farmers under 35 and over 20% aged 65 or older, there is growing concern about the sector's sustainability. Women represent about 22% of coffee farmers and tend to be younger compared to their male counterparts. While 78% of coffee farmers are male, women play a significant role in coffee production, as about 93% of farmer’s wives work on their coffee farms.  Furthermore, while 25% of

[1] https://www.gob.mx/agricultura/articulos/mexico-vs-la-roya-del-cafe

male farmers are over 65, only 8% of female farmers fall into this age group. Women also often shoulder more childcare responsibilities than men, and fewer women live with partners.

Most coffee farming households consist of 3.3 members, with 76% of these members being of working age. Typically, households have two earners; most work on the farm, with a few involved in off-farm activities. Despite limited formal education, coffee farmers average 23 years of experience. Educated youth from coffee farming families frequently seek employment outside of agriculture, while those with less education tend to remain in the field, raising concerns about the sector’s future.

The average coffee farm in Mexico spans 2.9 hectares, with many of these small farms managed by younger and female farmers. Minimal land market activity restricts farmers' ability to expand. Most land is dedicated exclusively to coffee cultivation, with limited diversification into other crops. Farmers practice intercropping and shade-growing to enhance income and soil health. Despite these efforts, productivity varies significantly, and fluctuating coffee prices impact earnings.

Production costs for coffee farmers in Mexico vary widely, averaging MXN 20,288 (approximately US $922) per hectare or MXN 2,143 (about US $97) per quintal of dry parchment.[2] Labor is the largest expense, making up 68% of total costs (family labor accounts for 37% and hired labor 31% of total costs). Labor for harvesting alone represents 48% of total production costs. Inputs like fertilizers and pesticides contribute 28% to the costs, while equipment depreciation adds another 4%. Costs differ significantly by state, with Oaxaca having lower costs due to reduced spending on inputs and labor.

When factoring in additional expenses like transportation, land opportunity costs, and amortization for new coffee trees, the total production cost rises to MXN 29,868 (approximately US $1,358) per hectare, reflecting a 47% increase compared to initial estimates in the paragraph above. Household incomes for coffee farmers average MXN 89,181 (about US$ 4,054) annually, which often falls short of meeting basic needs. Coffee alone contributes around 65% of total household income, with many farmers relying on wage labor and other agricultural activities to make ends meet. Despite coffee's profitability, many farmers struggle to cover their basic needs, resulting in a high percentage of those living below the poverty line.

The value chain efficiency reveals that most farmers engage in wet processing, which, while providing some price benefits, often compromises coffee quality. Total wet milling costs[3] average US$ 0.97 per kg of green bean equivalent (GBE), with additional expenses for dry milling and export. Vertical integration and better farmer organization could improve quality and profitability, but only a small fraction (17%) of farmers is currently part of organized groups that offer technical support and market access.

[2] One quintal of dry parchment is equivalent to 57.5 kg of GBE
[3] It includes direct wet milling costs (transport, labor, depreciation of equipment), operations of the wet mill, other costs and expenses, and profits.

Improvements in technical efficiency can significantly impact productivity and costs. Enhanced efficiency through better agricultural practices, optimized input use, and healthier coffee trees raises production costs per hectare but reduces costs per quintal. For example, farmers with median efficiency yield 8 quintals per hectare (460 kg per hectare) of dry parchment at a cost of MXN 15,773 (approximately US$ 717) per hectare. Boosting efficiency can increase productivity by 107% and reduce production costs per kg by 19%, leading to a substantial rise in net income.

However, even with significant efficiency improvements, poverty among coffee farmers remains a pressing issue. Although efficiency gains lead to a 51% increase in net income and slight reductions in poverty rates, these changes are insufficient to lift many farmers above the poverty line due to overall low-income levels. It is important to note that coffee farmers in Mexico face rather low productivity levels, and therefore, a critical policy issue lies in enhancing productivity. Notwithstanding, improving coffee quality is a significant step towards improving living income for coffee farmers.

On the other hand, price volatility is another major risk for coffee farmers, affecting their financial stability. Although high prices (US$ 4.04 per kg of GBE) in the 2021/2022 season provided some relief, lower prices could lead to negative incomes for many. Additionally, given heterogeneity amongst coffee farmers, it is crucial to tailor policies according to different farmer’s profiles, focusing on younger farmers, as they are more likely to engage in new technologies, which are critical to productivity enhancement and professionalization of the farming business.

# Introduction

The International Coffee Organization (ICO) serves as an intergovernmental organization fostering cooperation among coffee-exporting and importing nations. It represents a substantial share of the global coffee production and consumption. The ICO's mission centers around improving the coffee industry through collaboration, market information exchange, and partnerships with regional and international entities. In 2019, the ICO initiated the Coffee Public Private Taskforce (CPPTF), focusing on crucial themes like living and prosperous income, market transparency, policy and national dialogue, and resilient landscapes, all geared toward promoting sustainability within the coffee sector.

With the sponsorship of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), The Committee on Sustainability Assessment (COSA) and the ICO have united their efforts within the Technical Work Stream on Market Transparency (TWS II) to empower ICO member countries to strengthen their data capabilities and boost transparency. A team of skilled technical experts has developed methodologies and tools specifically tailored for data collection on vital topics such as coffee production costs, actual total household incomes of coffee farmers, and efficiency within the coffee value chain.

COSA, in partnership with the Secretariat of Agriculture and Rural Development (SADER) and its designated research institution, the National Institute for Forestry, Agriculture and Livestock Research (INIFAP), embarked on piloting the work of the ICO TWS II in Mexico. Since August 2022, the team has collaborated to refine and adapt these methodologies and tools to the local context of Mexico and execute the work. Throughout the process, COSA has focused on knowledge transfer to enable SADER and INIFAP to assume full ownership of the tools for independent use in future endeavors.

The ultimate aim of this work is to provide valuable insights that can sustainably enhance the well-being of coffee farmers in Mexico. By offering access to data on coffee production costs, total household incomes, and value chain efficiency, the initiative allows SADER to identify opportunities for optimizing coffee production and addressing potential bottlenecks within the coffee value chain, which may otherwise affect farmer income. Together with the ongoing living income benchmark study conducted in Mexico by the ICO's TWS I on Living and Prosperous Income in collaboration with SADER, the information gathered will also enable SADER and its partners to assess the living income gap. This comprehensive dataset is essential for directing targeted policy and investment to enhance the efficiency of the coffee sector in Mexico and uplift the livelihoods of coffee farmers. Furthermore, SADER is committed to sharing aggregated data with the ICO to contribute to global benchmarking and industry standardization efforts.

# 1. Background of the coffee sector in Mexico

Mexico’s coffee production thrives in the southern states of Chiapas, Veracruz, and Oaxaca thanks to a favorable tropical climate and mountainous terrain. These geographical advantages, along with Mexico's rich coffee heritage and focus on shade-grown, organic practices, boost its competitive edge in the international coffee market. In recent years, Mexico has produced around 158 thousand tons of coffee green beans annually (SIAP, 2023). Of these, exports are expected to reach about 100 thousand tons, with the US and European markets receiving 44% and 30% respectively. After breaking into the global top 10 for green coffee production by volume in 2023, Mexico is projected to maintain similar production levels in the 2023/24 market year, while domestic consumption is on a slight rise.

However, the Mexican coffee sector faces challenges due to limited support for smallholder farmers, inconsistent governmental policies and insufficient investment from the private sector. Rural poverty poses a significant obstacle across Mexico’s coffee-producing regions. The states of Chiapas, Veracruz, Puebla, and Oaxaca, responsible for over 90% of the country's coffee production, face high levels of marginalization and limited economic opportunities outside agriculture. In Chiapas, Mexico's poorest state, about half the population lives in extreme poverty, with coffee production being the main source of income for around a quarter of the labor force. In Oaxaca, many small-scale farmers also contend with low incomes and limited access to resources. Although the situation in Veracruz and Puebla is somewhat better, rural poverty still significantly affects coffee-growing communities.

In Mexico, the backbone of the coffee industry is formed by farmers from about 32 indigenous communities.[4] These communities, essential to the country's coffee production, have cultivated coffee as a cash crop since the early 1900s. Their deep-rooted agricultural traditions and sustainable farming practices continue to shape and sustain the industry today. The Secretariat of Agriculture and Rural Development (SADER) estimates that at least half a million farmers grow coffee in Mexico, with an average coffee farmer operating on less than 3 hectares, with around 90% managing holdings of 2 hectares or less. Women account for 22% of coffee producers nationwide and play a significant yet underrecognized role in the coffee sector. They participate in all aspects of production, from cultivation to harvesting and processing. Their involvement extends beyond farm ownership, with many contributing as family labor or agricultural workers.

[4] Aguirre-Cadena, J., Trejo B., Ramírez-Velarde, B. y F. Morales-Flores (2012). “Producción de café en comunidades indígenas de México: beneficios sociales y ambientales”. AgroProductividad, Vol(5) No(2), pp.34

A relatively small number of coffee producers are organized, with significant variation in the maturity of these organizations. The most structured organizations not only represent their members and arrange for various types of support but also engage in all stages of the coffee value chain. This includes procuring inputs and equipment, collection, dry method processing, and facilitating export. They may also offer additional support functions such as training, financing, certification and market access. Around 60% of small-scale coffee farmers remain unaffiliated with any trade or organizational body. These independent producers rely heavily on their own and their family’s labor, with occasional wage employees hired for the harvest. Their productivity levels are low, primarily cultivating for the conventional coffee market.

A pressing issue facing all small-scale coffee farmers in Mexico is the struggle to find enough labor during harvest and for the renovation and rehabilitation of coffee lands. Nationwide, it is estimated that the planting and harvesting seasons employ between 1.2 and 1.3 million people respectively, and in recent years, labor shortages have worsened. Traditionally, states like Chiapas and Veracruz have relied heavily on migrant labor for overall coffee activities, in particular harvesting. However, ongoing border closures and regional conflicts have significantly reduced the influx of these workers. Stricter immigration policies by the Mexican government have further curtailed the number of immigrants entering the country, exacerbating the labor shortage. Additionally, the tourism industry, offering higher wages, is drawing potential laborers away from agricultural work.

Mexico's coffee sector operates without direct government intervention in price setting, allowing market forces to determine coffee prices. The national government, through SADER, focuses on providing support programs aimed at assisting farmers. For instance, the Mexican agricultural sector program for 2020-2024 aims to boost productivity and sustainability in various agricultural subsectors. For the coffee industry, the program focuses on increasing production and improving quality through several initiatives. These include the distribution of rust-resistant coffee varieties, efforts to rehabilitate and renovate coffee plantations, and support for smallholder farmers. The program also aims to promote domestic coffee consumption and enhance Mexico's position in the global specialty coffee market.

In recent years, this program has played a crucial role in curbing the spread of coffee rust and boosting productivity. Coffee rust, the primary phytosanitary threat to coffee production, caused devastating harvest losses of 50% between 2012 and 2016. Traditional Arabica varieties like Typica, Caturra, and Bourbon remain common, but farmers are increasingly renovating plantations with disease-resistant varieties such as Oro Azteca, Marsellesa, and Costa Rica 95. Despite initial success these programs struggle with budget constraints, threatening the continuation of these vital replanting efforts.

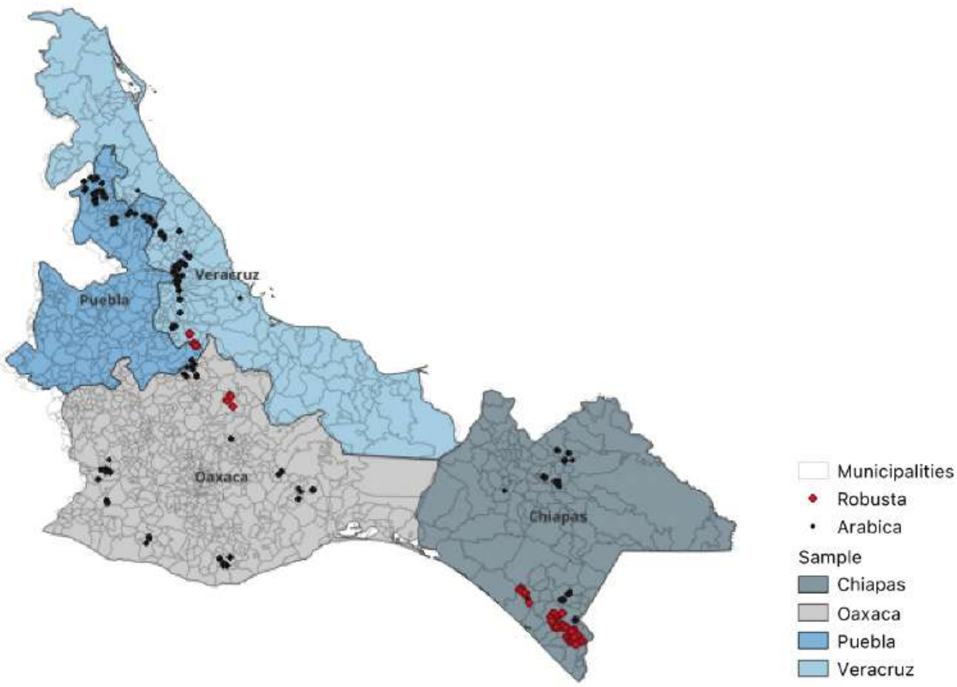
Similarly, the “Producción para el Bienestar” program provides financial assistance to small and medium-sized coffee producers. Additionally, the “Sembrando Vida” program encourages intercropping coffee with other crops like citrus and corn, offering subsidies to participants. Despite these initiatives, the impact of the programs seems limited due to its narrow focus on direct financial aid without addressing crucial needs such as financing, technical support, and marketing assistance.

# 2. Methodology

In Mexico there are 710,947 hectares of coffee distributed in 14 states that produce 947 thousand tons of coffee fresh cherries (SIAP, 2021).[5] Similarly, according to AMECAFE (2020), there are 545 thousand coffee farmers.[6] In order to reduce sample dispersion within all coffee producing states, the study focuses on four states that represent about 85% of the coffee area and 90% of total production, namely Chiapas, Veracruz, Oaxaca and Puebla (See Appendix 1 for details).

The study considered a proportional random sampling methodology to ensure an accurate portrayal of the Mexican coffee sector. Calculations led to a sample size of 883 coffee farmers, yielding a margin of error of 5.6% with a confidence level of 95%. Total sample was distributed amongst 55 municipalities in 4 states, averaging 16 coffee farmers per municipality (24 in Chiapas, 11 in Oaxaca, and 15 in each, Puebla and Veracruz).

**Figure 1. Map of Mexico and the sample layout**




[5] https://www.gob.mx/cms/uploads/attachment/file/885769/1_Enero_Cafeto_2023.pdf
[6] Ibid

# 3. General characteristics of the sample

Given the importance of Arabica coffee growers in Mexico, this report focuses on farmers that exclusively grow Arabica coffee, while also discussing Robusta coffee growers where relevant. Research shows that while Arabica coffee dominates (over 80% of coffee farmers), some farmers produce Robusta coffee either exclusively or alongside Arabica.[7]

## 3.1 Farmers and their farms

### Gender and age matter

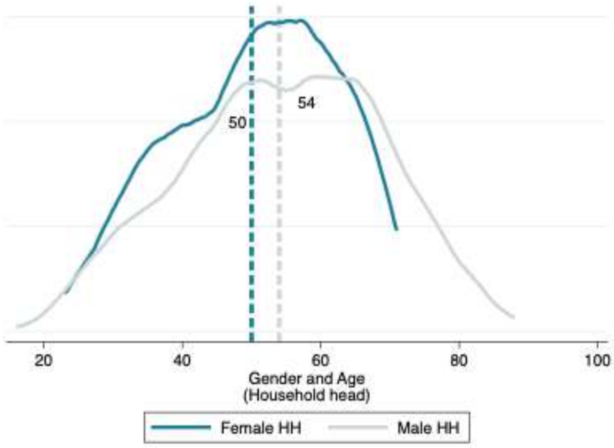
In Mexico, coffee farmers are getting older, creating significant challenges for the coffee sector, especially with younger generations losing interest in coffee farming. The average coffee farmer is 54 years old, with minimal variation across states. Remarkably, there is a concerning imbalance in age demographics, with only around 11% of respondents under 35 (the youth category) and over 20% above 65 years old.[8]

The research indicates that around 22% of coffee farmers are women who tend to be younger than their male counterparts. For instance, about a quarter of male farmers are over 65, compared to just 8% of female farmers, as shown in Graph 3.1.1. Only 42% of female farmers live with their partners, contrasting sharply with 78% of male farmers. (see Table A3.1 in Appendix 3). Moreover, female coffee farmers without partners shoulder twice the burden of childcare (for children aged 12 or below) compared to their male counterparts.

[7] Robusta coffee is found primarily in Chiapas (35% of farmers), but also in Veracruz (7.7%) and Oaxaca (1.1%). Research shows that 76% of farmers that grow Robusta coffee, only grow this coffee variety, and 24% grow a combination of Robusta and Arabica coffee.

[8] Robusta coffee farmers are, on average, older (57 years old). In fact, only 6% are less than 35 years, and more than a quarter are 65 or older. Furthermore, there is a significantly larger proportion of male farmers (85% as compared with 78% within arabica growers).

**Graph 3.1.1: Coffee farmers' age, by gender**




## Coffee farmers may lack formal education, but they hold a wealth of expertise in coffee farming.

A considerable labor force is available within households to engage in agricultural activities. Households average 3.3 members, with 76% being of working age (over 18 years old). Research shows that households have on average, 2 earners[9] (either temporary or full time employed) of which 93% are engaged in on-farm agricultural activities and 32% perform off-farm income-generation economic activities. Despite their limited formal education, 68% having completed primary education and only 36% secondary, producers bring an impressive 23 years of coffee farming experience on average. This rich reservoir of practical knowledge equips them with essential skills in coffee production management and key agricultural practices (see Table A3.1 in Appendix 3).[10]

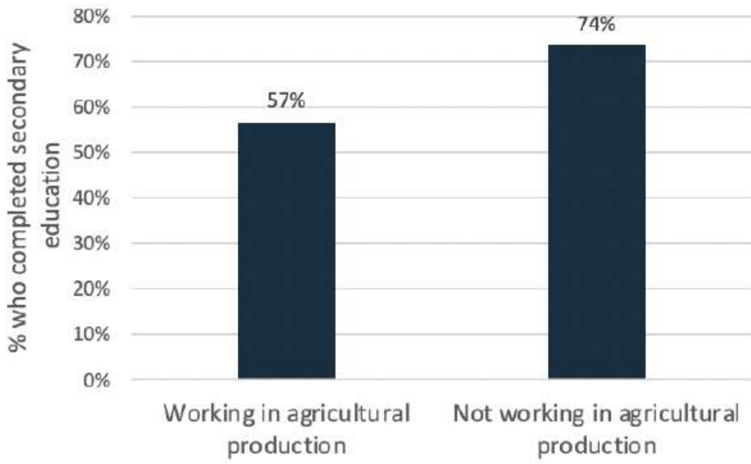
## Most formally educated youth in coffee farming households pursue off-farm employment opportunities.

When it comes to the next generation of coffee farmers, the less formally educated youth often stay within the agricultural sector. Roughly a quarter of adult household members (excluding the household head) fall into the young demographic bracket, aged 18 to 35 years old, with around 56% of them employed in agriculture. Data indicates that younger and better formally educated individuals gravitate to off-farm activities, as shown in Graph 3.1.2, primarily due to the lower expected returns in coffee farming.[11] This trend raises concerns about the long-term viability of coffee farming, especially given the aging farmer

[9] We only consider household members aged 18 or more for any employment related indicator.
[10] Robusta coffee farmers have lower level of schooling (only 28% have completed secondary school) and have on average three years less of coffee farming experience (20 years) than arabica coffee farmers.
[11] For example, the remuneration for agricultural labor typically ranges between MXN 150 and 200 (USD 6.82- 9.09) per day. According to our survey data, alternative employment in different sectors generates an average of 270 MXN (USD 12.27) per day.

demographic and their reluctance to adopt productivity-enhancing activities (as outlined in Table A3.1 in Appendix 3).

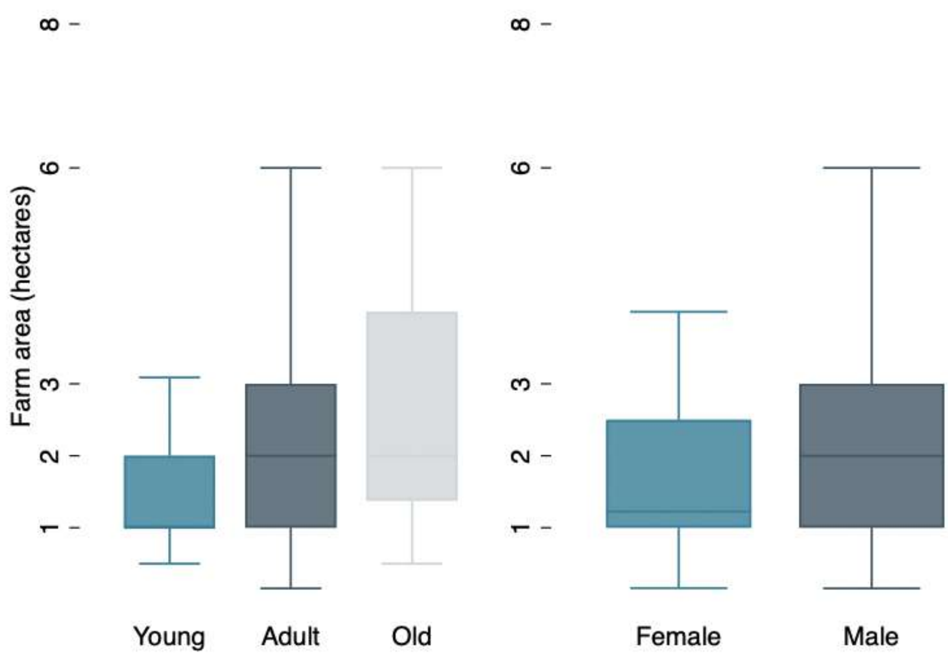
**Graph 3.1.2: Next generation's education and employment**




## Coffee farmers manage small-scale operations

Most coffee farmers are smallholders, with an average farm size of 2.9 hectares and a median value of 2.0 hectares. About one-third of farmers have 1 hectare of land or less with smaller farms typically run by female and younger farmers (Graph 3.1.3).

**Graph 3.1.3: Farm size, by age group and gender**

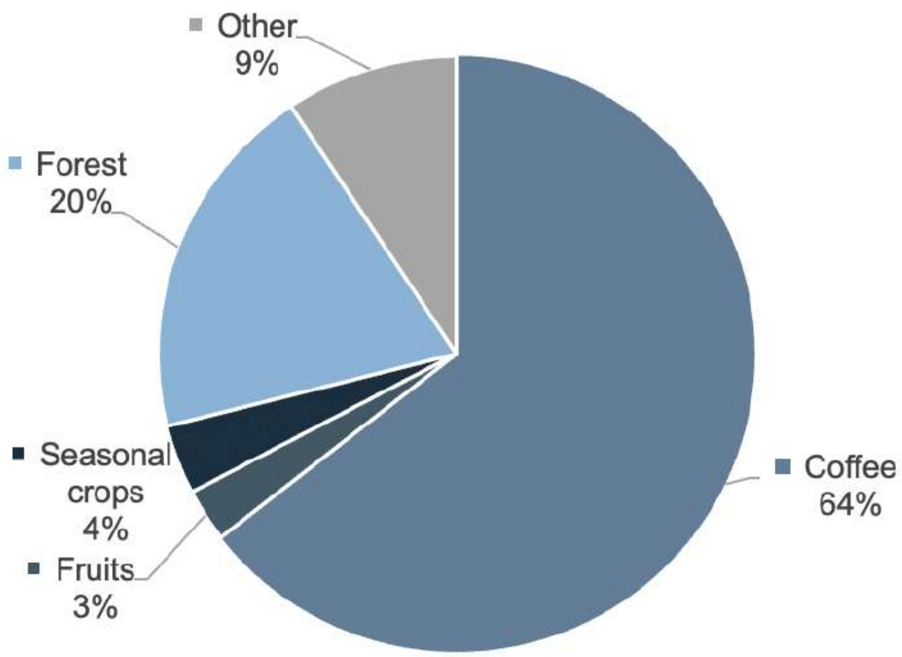


### Coffee farmers concentrate solely on coffee for their income, without diversifying into other crops or fruits.

Farmers allocate most of their land to coffee, with seasonal crops and fruits representing a significantly smaller portion. On average, coffee cultivation covers 1.88 hectares (64% of the total farm area), while seasonal crops and fruits occupy just 0.19 hectares, (7% of total farm area). Forested areas and other uses make up respectively 20% and 9% of the remaining area[12] (see graph 3.1.4 and Table A3.2 in Appendix 3).

Research indicates that nearly 73% of Arabica coffee farmers cultivate coffee across all their farm plots, and only 38% of them have their coffee intercropped. The remaining 27% cultivate coffee in about half of their farms (intercropped or not) diversifying the productive use of their land.

**Graph 3.1.4: Average land use**




In general, coffee farmers tend to allocate a larger portion of their land to coffee cultivation, thereby heavily relying on this activity for their agricultural income. Approximately 45% of arabica coffee farmers grow coffee exclusively on their land (mono-croppers), although the large majority cultivate their coffee under shade trees which provide potential benefits for ecosystem health and soil fertility (see next section). About 45% cultivate an average of 1.4 crops, either in specific areas or intercropped with coffee, and the remaining 10% only cultivate coffee, but have other land uses (forest, fallow,

[12] Around 96% of Robusta coffee growers have all their farm planted with coffee, although the large majority of them also intercrop coffee with other species

uncultivated land). Furthermore, assessing crop diversification using the Herfindhal Index reveals minimal crop diversification among coffee farmers in Mexico, with slight variations between larger and smaller farms.[13]

The primary crops cultivated by Arabica coffee growers in Mexico include banana (13% of the sampled farmers), citrus (12%), maize (12%), and plantain (11%). Additionally, coffee farmers cultivate other crops to a lesser extent (see Table 3.1.1).

**Table 3.1.1: Crop diversification and land size**

| Farm Area (ha) | Coffee area / Total farm area | Number of crops (excluding coffee) | Herfindahl Index of crop diversification |
|---|---|---|---|
| < 1 ha | 97.6% | 1.31 | 0.08 |
| Between 1 - 2 ha | 91.1% | 1.38 | 0.06 |
| Between 2 - 3 ha | 87.9% | 1.40 | 0.04 |
| Between 3 - 5 ha | 69.5% | 1.44 | 0.10 |
| More than 5 ha | 50.3% | 1.35 | 0.08 |
| Average | 86.3% | 1.36 | 0.07 |

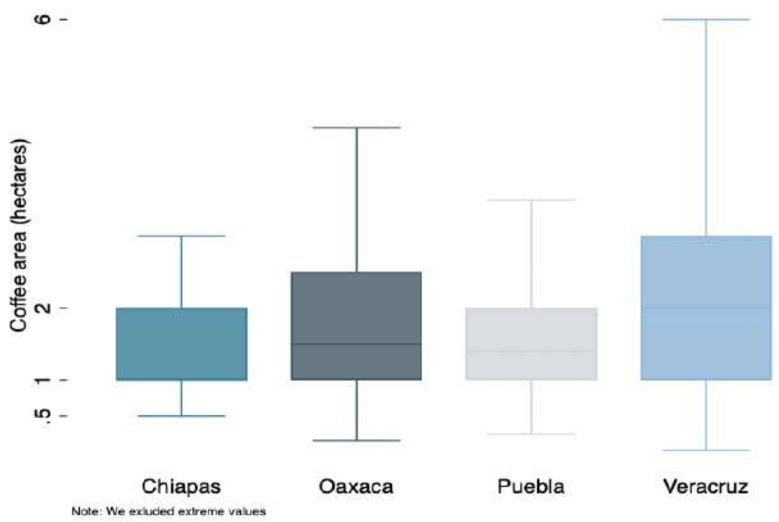
## 3.2 Main characteristics of coffee farms

### Coffee is typically cultivated in small, shaded plots and intercropped with other crops.

Arabica coffee in Mexico is typically cultivated on small, scattered and gently sloping plots of land. Farmers usually have 1.88 hectares of coffee, usually spread between 1 and 2 plots. The distribution of coffee area is right-skewed, with a median value of 1.5 hectares, where 44% of coffee farms have 1 hectare or less and 20% have 3 hectares or more (see Graph 3.2.1). In Veracruz, farms are larger, (averaging 2.3 hectares) compared to Chiapas and Puebla (1.7 and 1.6 hectares, respectively).

[13] The Herfindhal Index (HI) can be expressed as HI = j = 1Jpj2, where J is the total number of crops, p is the proportion of the area of crop j over the total cultivated area. A value closer to zero indicates specialization, while a value closer to 1 indicates full diversification.

**Graph 3.2.1: Coffee Area (ha), by province**




Arabica coffee is grown at altitudes of 400 – 2,200 meters above sea level (m.a.s.l.),[14] generally on gently sloping terrains (65%). However, 32% of coffee trees are on steep slopes, especially in Chiapas (32%) and Oaxaca (38%).

Shade-grown arabica coffee is a widespread practice in Mexico, offering potential benefits for ecosystem health and soil fertility. Shaded environments provide essential nutrients to coffee trees and soil while also acting as a natural deterrent to pests. Approximately 20% of farmers cultivate their coffee in farms where shade covers at least 75% of the area, and about 66% of farmers do so in farms where shade covers more than 40% of the terrain.

Intercropping is another common practice among Mexican coffee farmers enhancing both income potential and food security. Intercropping is particularly relevant when coffee plants are not yet productive. Around 80% of coffee farmers intercrop their coffee plots with seasonal crops or permanent cultivations such as fruit trees. Moreover, approximately one-fourth of farmers intentionally use intercropping to boost nitrogen levels in their coffee plots (see Table A3.3 in Appendix 3).

### Coffee trees are relatively young, and farmers actively engage in coffee renovation.

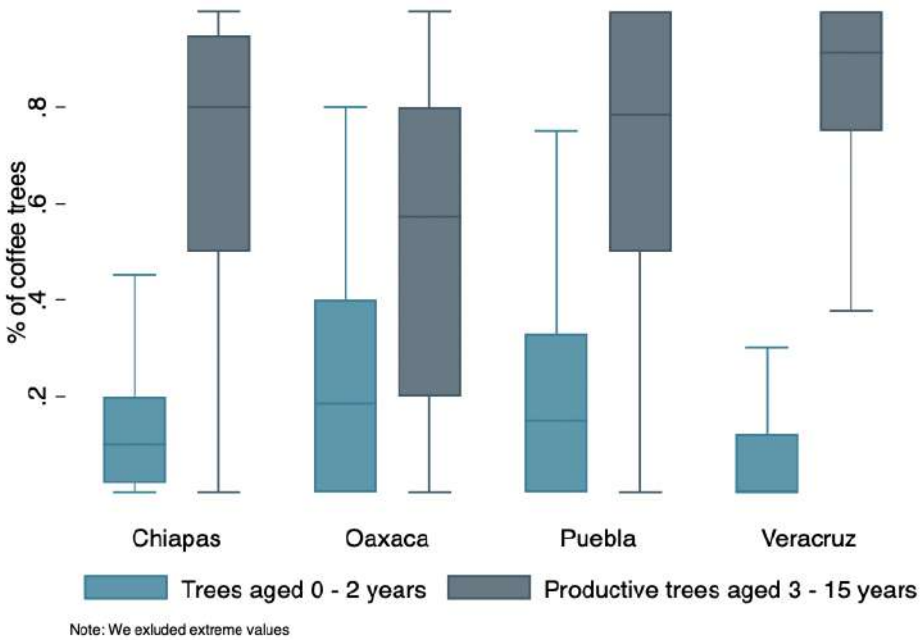
Around 77% of coffee trees are currently in production, with the remainder recently replanted (11%), newly added (10%), or rehabilitated (3%). Approximately 17% of all Arabica coffee trees are aged two years or less, and about 61% of coffee farmers have undertaken some degree of coffee renovation. This renovation has a pivotal correlation

[14] Robusta coffee is cultivated within an altitude range of 100 – 1300 m.a.s.l, mostly in mild sloping terrains.

with factors such as farmer demographics (age) and key characteristics of coffee farming (area, renovation, altitude, tree density, amongst others) (See Appendix 3, table A3.4)

Furthermore, about 68% of total coffee trees are young and in their most productive age range (3 – 15 years). This proportion is notably higher in Veracruz (81%), followed by Puebla (70%), Chiapas (68%), and to a lesser extent, Oaxaca (51%).

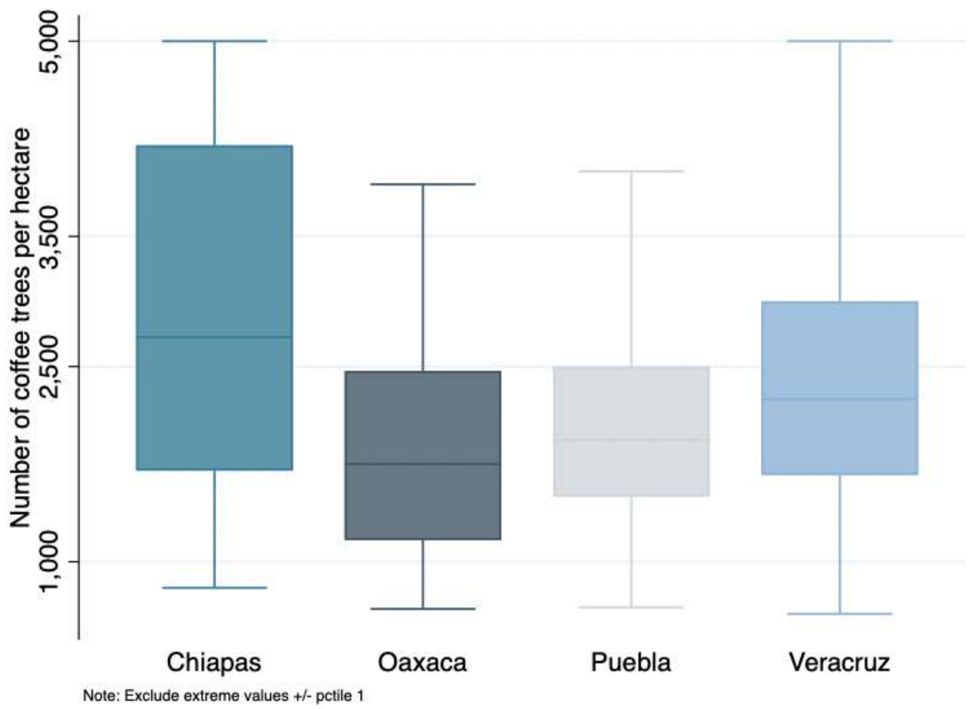
**Graph 3.2.2: Coffee renovation and productive trees, by province**




## Coffee tree density varies significantly.

In Mexico, the average Arabica tree density is 2,300 trees per hectare. The median density is 2,133 coffee trees per hectare, with significant variation: the lower 5$^{th}$ percentile has 868 trees per hectare, and the upper 95$^{th}$ percentile has around 4,400. Heterogeneity is also evident when assessing tree density within states. Chiapas shows the highest tree density (2,913 trees per hectare) and the greatest variance compared to Veracruz (2,338), Puebla (2,026) and Oaxaca (1,789). More than a quarter of Chiapas' coffee farmers maintain densities over 4,400 trees per hectare, significantly higher than the other states, while in Oaxaca, about a quarter of coffee farmers have a tree density below 1200 trees per hectare.

**Graph 3.2.3: Coffee trees per hectare, by province**



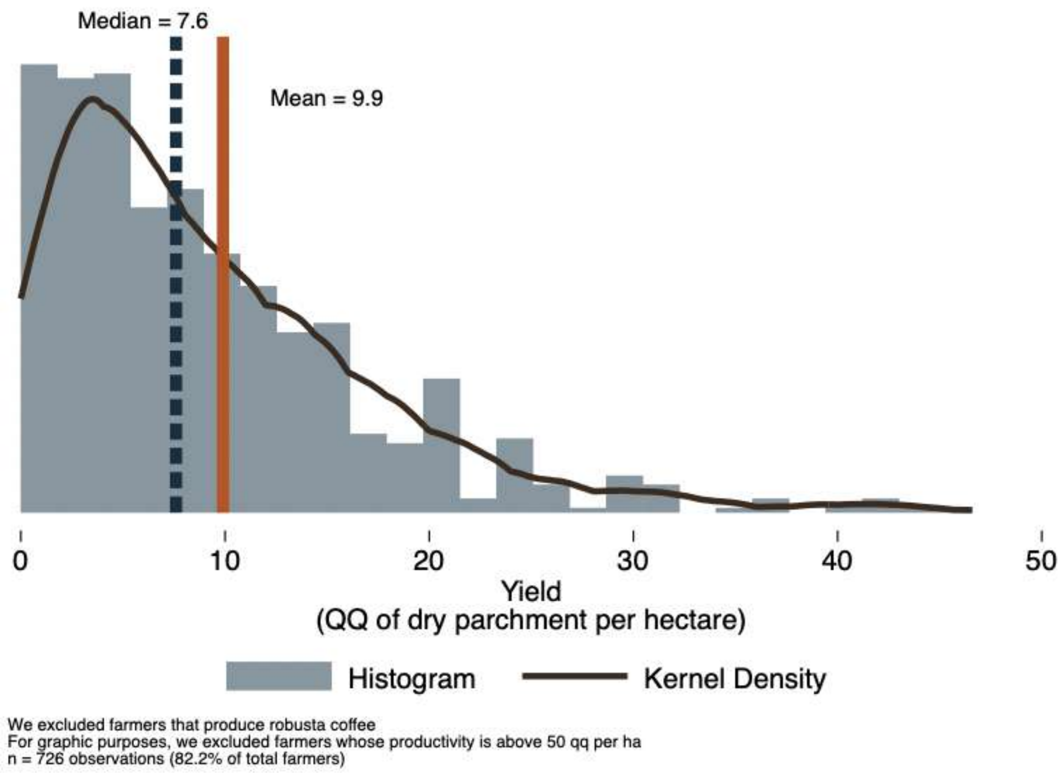

## 3.3 Coffee productivity and prices

Productivity levels remain low and vary significantly across different areas.

Farmers who exclusively produce Arabica coffee achieve an average productivity rate of 9.9 quintals of dry parchment per hectare (365.5 kgs GBE per hectare). Productivity varies widely, with a median of 7.56 quintals of dry parchment per hectare.[15] Approximately 25% of coffee farmers yield less than 3.5 quintals per hectare. Conversely, over 20% exceed 15 quintals of dry parchment per hectare (see Graph 3.2.1).

[15] 1 quintal of dry parchment = 57.5 kilos

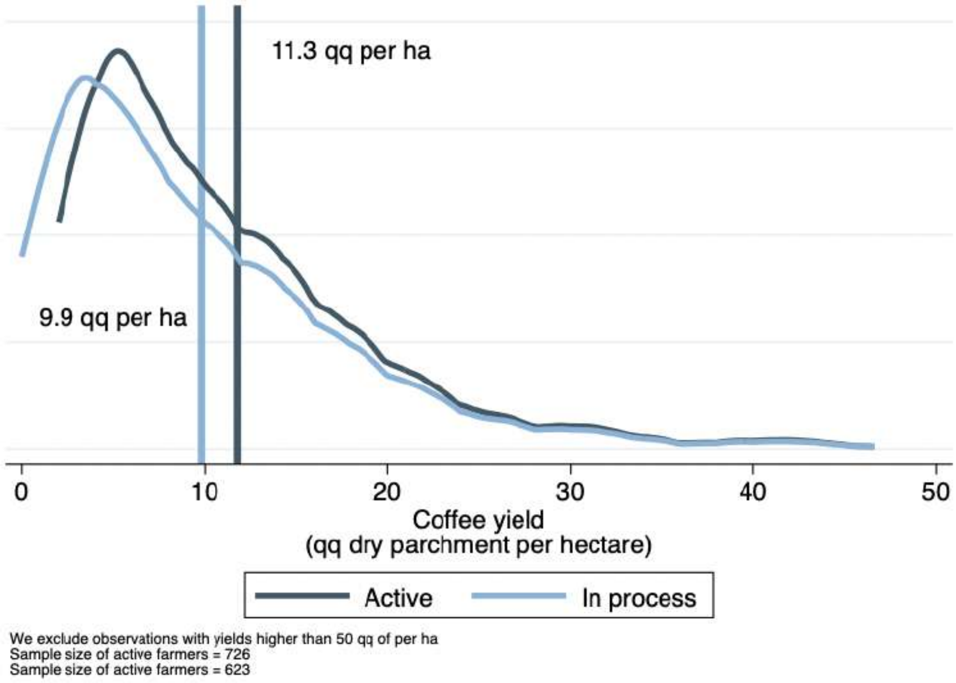
**Graph 3.3.1: Distribution of production (quintals of dry parchment) per hectare**




To better characterize the target group for coffee-related policies, this assessment focuses on “active” farmers. These are defined as farmers who exclusively produce Arabica coffee and have incentives to invest in their crop. These incentives include a minimum production of 2 quintals of dry parchment per hectare (74 kg GBE per hectare) and selling their coffee in the market, (excluding self-consumption).[16] The graph below shows that “active” farmers produce an average of 11.3 quintals of dry parchment per hectare (422.6 kg GBE per hectare), with a median value of 8.7.

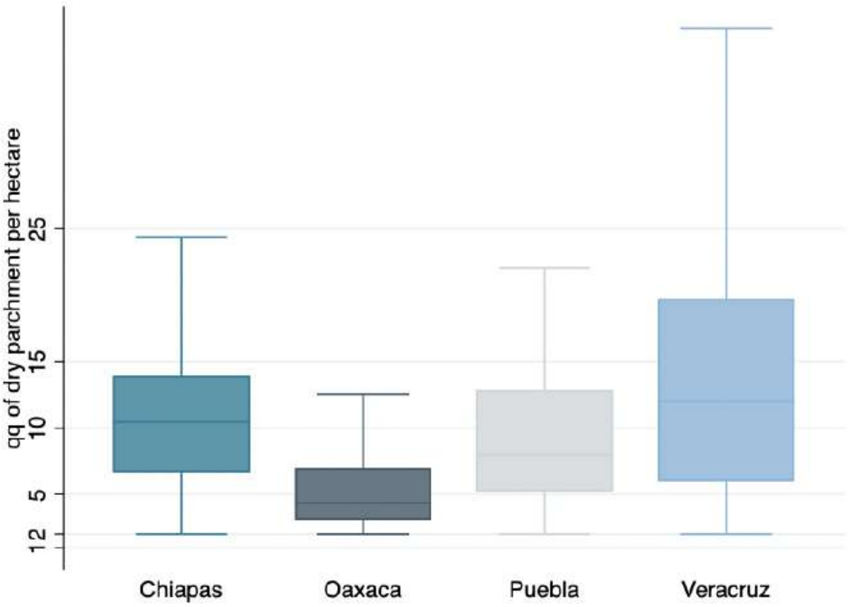
[16] The vast majority of coffee farmers that produce below 2 quintals of dry parchment per hectare have declared they have either abandoned their coffee or that it is yet to be productive.

**Graph 3.3.2: Compared distribution of productivity from active / inactive coffee farmers**




Arabica coffee yields show significant disparities both between and within states (see Graph 3.3.3 below). This variation in yields is closely linked to various factors, including farmer characteristics (such as gender or empowerment), geographical factors (state), coffee characteristics (area, number of coffee trees per hectare, percentage of coffee trees in productive age), occurrences of shocks (droughts, floods, plagues or diseases), and the implementation of Good Agricultural Practices (fertilization, certification). For a detailed assessment of these factors, please refer to Appendix 4.

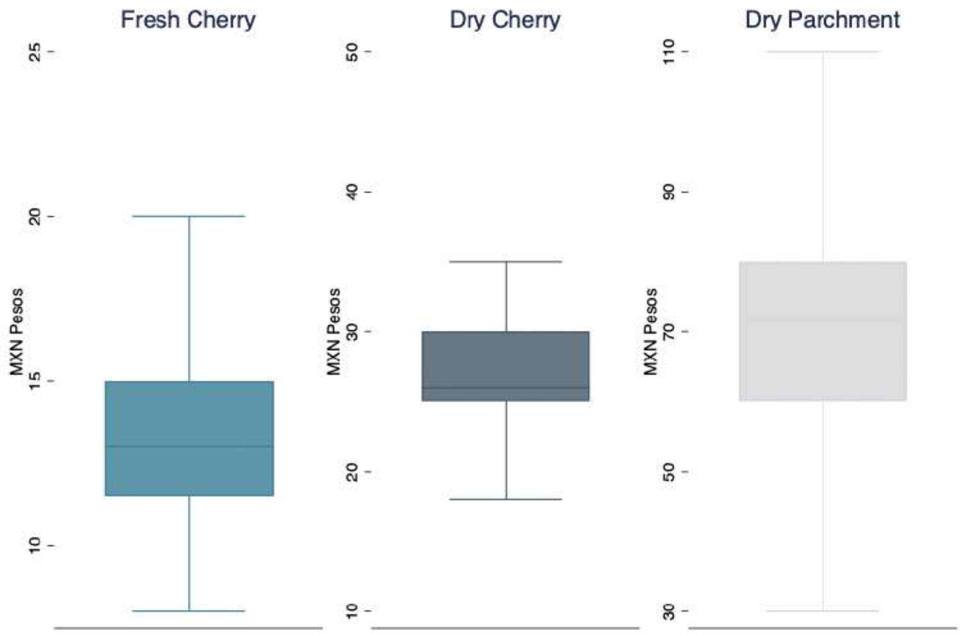
**Graph 3.3.3: Distribution of production per hectare of active coffee farmers, by state**



## Prices are heterogeneous

The coffee prices paid to farmers vary significantly. Average price per kilogram of fresh cherries is MXN 13 (US$ 0.59), with a range from MXN 8 to MXN 25 (US$ 0.36 to 1.14), while the average price per kilogram of dry parchment is MXN 70 (US$ 3.18), ranging from MXN 30 to MXN 140 (US$ 1.36 to 6.36). Research shows that certified farmers[17] receive prices that are 6% to 7% higher than those of non-certified farmers. Moreover, exporters, cooperatives, or processors pay prices that are 10% to 12% higher than those offered by local intermediaries. Lastly, wet-processed coffee fetches about 8% more than coffee sold as fresh cherries.

**Graph 3.3.4: Distribution of prices paid by coffee product**




Note: We exluded extreme values

[17] We specifically refer to coffee certifications from Organic, Rainforest Alliance, and Fairtrade International.

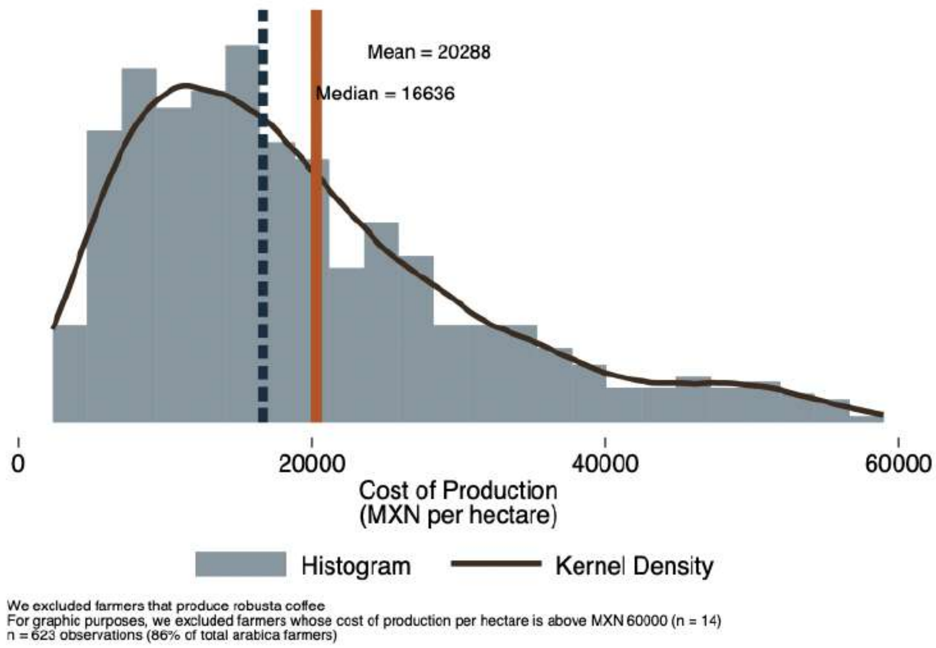
# 4. Key Findings

## 4.1 Costs of production

For a comparative analysis, the study adopted the methodology outlined by Church and Clay (2016) which was also used in the COSA GIZ- ICO 2024 Coffee Value Chain report for Rwanda.[18] This approach evaluates production costs based on four key elements: (i) household labor (by task),[19] (ii) wage labor (by task), (iii) replacement value of equipment (including pruning tools, shears, sprayers, etc.); and (iv) value of non-subsidized inputs (fertilizers, pesticides, mulch, etc.).[20]

The average production cost for coffee farmers is MXN 20,288 (approximately US$ 922.20) per hectare, equating to MXN 2,143 (approximately US$ 97.4) per quintal of dry parchment (US$ 2.62 per Kg GBE). Production costs show significant variability and follow a right-skewed distribution as illustrated in Graph 4.1.1.

**Graph 4.1.1: Distribution of costs of production per kg of cherry**

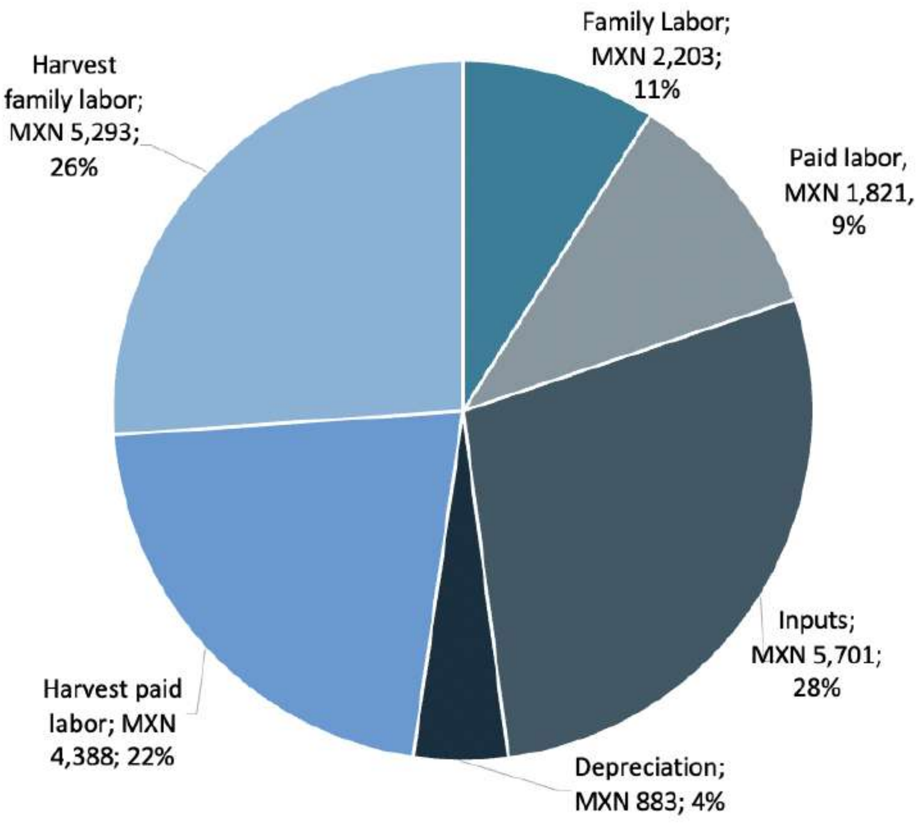



[18] To access the Rwanda report, please visit the International Coffee Organization’s CPPTF Knowledge Hub using the following link.
[19] This calculation is particularly relevant for cost of production assessments given its importance amongst smallholders.
[20] Some other costs provided in the survey were excluded for comparison purposes, such as transportation (marketing cost), cost of credit, the cost of land and the amortized cost of replanting coffee, which were considered in the next section. For more detail on production costs, please see Appendix 5.

Labor costs account for approximately 68% of total production costs (CoP), with household labor comprising 55% of total labor used. Harvesting labor represents 48% of total production costs, while other coffee cultivation activities average 20%. Total inputs represent 28% of total production costs, with the depreciation or replacement value of equipment making up 4%. Notably, production costs hinge heavily on labor, with a significant reliance on household labor, as illustrated in Graph 4.2.1.

Input expenditures include both direct purchases and the opportunity costs of using these inputs instead of selling them in the market. Around 92% of the total input costs originate from chemical fertilizers purchased in the market: such as urea and combinations of Nitrogen-Phosphorus-Potassium (NPK) (17-17-17, 18-12-06, Yaramila). Organic fertilizers and foliar products account for around 8% of total input costs.

**Graph 4.2.1: Structure of production costs**




Production costs exhibit substantial variation, primarily due to significant differences between states (See table 4.1 below).[21] Oaxaca has the lowest production costs, mainly due to lower expenses on inputs (chemical and organic fertilizers, as well as foliar products) and paid labor. However, differences within states are also relevant and are

[21] For details, refer to Appendix 5, table A5.1

influenced by factors related to farmers' characteristics (age), farm characteristics (percentage of productive trees, assets), agroecological factors (such as altitude and state), access to information (knowledge of coffee quality, record keeping, price) and the presence of other income sources (See Appendix 5, table A5.5 for an overview of the determinants of production costs).

**Table 4.1.1: Production costs per state**

| Costs per hectare | | State | | | | Average |
|---|---|---|---|---|---|---|
| | | Chiapas | Oaxaca | Puebla | Veracruz | |
| Coffee cultivation | Paid labor | 2,278 | 1,157 | 1,526 | 1,891 | 1,821 |
| | Family labor (opportunity cost) | 1,523 | 1,851 | 3,235 | 2,390 | 2,203 |
| Inputs | Fertilizers, pesticides, etc. | 7,142 | 1,641 | 6,576 | 5,694 | 5,701 |
| Depreciation | Productive assets | 1,284 | 813 | 405 | 827 | 883 |
| Harvest | Paid labor | 4,245 | 1,151 | 4,520 | 6,170 | 4,388 |
| | Family labor (opportunity cost) | 3,293 | 4,539 | 5,704 | 7,552 | 5,293 |
| | Total cost of production | 19,766 | 11,152 | 21,965 | 24,523 | 20,288 |

When considering a robust set of variables to assess production costs, the average total production costs for Mexican farmers amount to MXN 29,868 (approximately US$ 1,358) per hectare.

To better understand farmers' production costs, a variety of significant cost sources influencing their decision-making processes were included in the analysis. Full production costs amounted to MXN 29,868 per hectare (equivalent to MXN 3,242 per quintal of dry parchment), a 47% increase compared to the previous cost estimation. The additional components considered were:[22]

- **Cost of transportation:** Transportation is usually recognized as a commercialization expense, concluding when farmers deliver their produce to the buyer. Thus, the cost of hiring transportation services or the opportunity cost if the farmer delivers the coffee personally was incorporated.
- **Amortization cost of establishment of perennial crops:** This includes the replacement value of old trees with new trees, and labor costs linked to coffee nursing, land preparation and coffee planting.[23] It is worth noting that not all

[22] Cost of credit was excluded as only 3% of coffee farmers declared having credit from either formal or informal institutions.

[23] It was assumed that all activities, including nursing, land preparation, and planting, would require a total of 84 labor-days per hectare per year. Additionally, farmers were presumed to allocate 10% of their coffee area to renovation.

farmers face these costs, with only 63% reporting some degree of new coffee trees. However, factoring in these expenses is crucial for sustaining the plot's productivity over time.

- **Cost of land:** This cost represents the opportunity cost of land, equivalent to the income the farm owner would have received if they rented out their land. This cost is crucial, especially for farmers looking to expand their land or where there is an active land market. To address these opportunity costs, the marginal productivity of land was estimated, equating to the annual rental price of land.[24]

**Table 4.1.2: A comprehensive account of production costs**

| Costs per hectare | State | | | | Average |
|---|---|---|---|---|---|
| | Chiapas | Oaxaca | Puebla | Veracruz | |
| Total paid labor (cultivation + harvest) | 6,523 | 2,307 | 6,046 | 8,061 | 6,209 |
| Total family labor (cultivation + harvest) | 4,816 | 6,391 | 8,938 | 9,941 | 7,496 |
| Inputs (fertilizers, pesticides, etc.) | 7,142 | 1,641 | 6,576 | 5,694 | 5,701 |
| Depreciation of productive assets | 1,284 | 813 | 405 | 827 | 883 |
| Transportation costs | 1,642 | 1,130 | 1,089 | 2,047 | 1,564 |
| Cost of land | 6,306 | 4,020 | 5,615 | 6,719 | 5,916 |
| Amortization costs | 2,100 | 2,100 | 2,100 | 2,100 | 2,100 |
| Total cost of production | 29,813 | 18,402 | 30,770 | 35,389 | 29,868 |

Total comparable cost per hectare = MXN 20,305

Added costs per hectare = MXN 9,580

## Farmers often underinvest in their coffee crops, leading to predictably low returns. However, there is substantial potential for boosting investment in coffee production, which could yield significant returns.

The most productive farmers (upper quantile of yield distribution), who yield an average of 26 quintals of dry parchment per hectare (1495 kg of dry parchment per hectare; 961 kg GBE per hectare), incur significantly lower expenses per unit of produce compared to the average farmer, resulting in higher profits. Comparing farmers in quantile III and quantile V, data shows that by doubling the average investment in coffee production (increase in comparable production costs), farmers can nearly triple yields, reduce the cost of production per quintal of dry parchment by over 25%, and increase net profits by more than five times (See Table 4.1.3 below). The most productive farmers typically have a higher density of coffee trees per hectare and apply significantly more inputs. They use more total labor with greater intensity but rely less on family labor. Their coffee plantations are younger and healthier coffee plantations. Additionally, these farmers are more likely to be certified and have better access to information both directly or indirectly

[24] For details regarding the estimation of the marginal productivity of land, see Appendix 5.

related to coffee production. As a result, they are less economically dependent on coffee (See Appendix 5, table A5.5).

**Table 4.1.3: Coffee investments, productivity and net profits**

| | Coffee productivity (in quintals of dry parchment per hectare) | | | | | |
|---|---|---|---|---|---|---|
| | Inactive (< 2) | Quintil I (2 - 4.3) | Quintil II (4.4 - 7.2) | Quintil III (7.3 - 10.7) | Quintil IV (10.8 - 16.1) | Quintil V (16.3 - 70.0) |
| Average yield (qq dry parchment per ha) | 1.04 | 3.21 | 5.73 | 8.90 | 13.61 | 25.99 |
| Using comparable costs of production: | | | | | | |
| Cost of production per ha | 5,440 | 9,747 | 13,231 | 18,079 | 23,338 | 37,906 |
| Cost per qq of dry parchment | 10,496 | 3,074 | 2,326 | 2,032 | 1,715 | 1,528 |
| Return on investment | -4% | 71% | 97% | 122% | 160% | 190% |
| Net income from coffee | - 2,250 | 9,715 | 15,053 | 25,107 | 47,316 | 132,591 |
| Using extended version of costs of production: | | | | | | |
| Cost of production per ha | 10,744 | 15,108 | 19,705 | 26,923 | 35,686 | 52,990 |
| Cost per qq of dry parchment | 23,264 | 4,843 | 3,462 | 3,030 | 2,624 | 2,180 |
| Return on investment | -59% | -6% | 19% | 34% | 52% | 96% |
| Net income from coffee | - 13,174 | - 1,655 | 4,092 | 10,858 | 27,680 | 100,715 |

## 4.2 Total household income

Farmers often diversify their income sources, yet total earnings still fall short of meeting their basic needs. Approximately 72% of coffee farmers fail to reach the poverty line with their paid labor income, averaging only 86% of the threshold.

The aggregate total annual household income[25] for active arabica coffee farmers in Mexico is MXN 89,181 (approximately US$ 4,054), which stems from five different sources: coffee farming, other crop farming, participation in the labor market (off-farm or on-farm), income from family business, and the value of family labor included in the costs of production.[26]

Coffee farming serves as the primary source of income, representing around 51% of total household net income on average, with about 40% of farmers relying exclusively on coffee

[25] The study does not account for non-labor sources of income which include social programs and agricultural programs that complement coffee farmers income.

[26] Note that net income from coffee farming includes as a cost the value of family labor. Therefore, we have to consider that "payment" into the household income, such that in the net calculation, it balances out.

income. Moreover, per capita net income from coffee farming accounts on average for 56% of the poverty line.

The average annual net income from coffee is MXN 45,962 (approximately US$ 2,089), though this figure varies significantly across and within states. Veracruz boasts the highest average net income from coffee production (MXN 69,586), 51% above the average, followed by Chiapas, which is slightly below average. In contrast, Oaxaca and Puebla have an average annual net income below MXN 31,000 (approximately US$ 1,409). About 89% of sampled coffee farmers report positive net income, while 11% have experienced losses. Negative outcomes are strongly correlated with factors such as the presence of a large proportion of young unproductive trees, a large proportion of old trees, external shocks (droughts, floods, extreme winds), low tree density[27] (See table 4.2.1 below).

**Table 4.2.1: Coffee annual net income**

| | | Coffee net income | Ratio of coffee income to total income | Net coffee margin | % with negative outcomes |
|---|---|---|---|---|---|
| State | Chiapas | 43,619 | 82% | 161% | 8% |
| | Oaxaca | 26,737 | 61% | 167% | 6% |
| | Puebla | 30,583 | 54% | 74% | 22% |
| | Veracruz | 69,586 | 73% | 109% | 10% |
| Yields (qq of dry parchment) | Inactive (<2)* | 1,648 | 43% | -4% | 63% |
| | Quintil I (2 - 4.3) | 11,512 | 55% | 71% | 34% |
| | Quintil II (4.4 - 7.2) | 16,299 | 62% | 97% | 12% |
| | Quintil III (7.3 - 10.7) | 25,357 | 71% | 122% | 4% |
| | Quintil IV (10.8 - 16.1) | 48,289 | 75% | 160% | 5% |
| | Quintil V (16.3 - 70.0) | 132,591 | 88% | 190% | 0% |
| Coffee area (has) | < 1 ha | 19,295 | 63% | 125% | 15% |
| | 1 - 2 has | 43,913 | 72% | 136% | 8% |
| | 2 - 3 has | 64,650 | 82% | 123% | 11% |
| | 3 - 5 has | 109,877 | 80% | 108% | 11% |
| | 5 - 10 has | 201,119 | 78% | 155% | 0% |
| | Average | 45,962 | 70% | 128% | 11% |

* We have only included the "inactive" coffee farmers here for comparability

[27] Research shows that 63% of inactive coffee farmers have negative net incomes from coffee farming. Inactive coffee farmers are farmers who either do not sell their coffee in the market or produce less than 2 quintals of dry parchment per hectare.

The study shows that coffee is the most important income source for the majority of coffee farmers (63%).[28] Despite coffee being financially profitable (average return of 128%), net coffee incomes are relatively low in absolute terms due to low productivity levels and smallholdings. Coffee net income falls far below the rural national extreme poverty line,[29] with only 22% of active arabica coffee[30] farmers being able to afford a basic food basket solely with their coffee earnings.

Farmers are typically pluri-active and pursue a myriad of economic activities to complement their agricultural income. The second most important source of income is wage labor, which represents on average 21% of total household income. Labor markets in rural Mexico are active as 33% of households have at least one member engaged in paid labor activities. Wage income is particularly relevant in Puebla and Oaxaca, where it represents 33% and 31% of total household income.

Following in importance are other sources of agricultural income[31] which account for 9% of total household income (14% in Puebla) and represent on average 0.2 hectares of farm area. Research found that around 40% of coffee farmers engage in other crop production. In Chiapas and Veracruz, farmers typically engage in banana production (26% and 13%, respectively), while in Oaxaca and Puebla, farmers produce maize (27% and 14%, respectively), citrus (19% and 18%), plantain (31% and 18%), and others.

Merely 10% of households declare having at least one family member engaged in a family-owned business unrelated to their typical agricultural activities. The limited number of farmers with business income results in its contribution to the total income averaging around 4% (See Table 4.2.1 below).

Finally, we have included the value of the family labor employed in coffee farming, which represents 13.8% of total household income. This value was incorporated into the total cost of coffee production estimation, as family labor has an opportunity cost in the labor market. This approach allows for a more precise estimation of total production costs. To make the calculations of total household income more accurate, it is essential to assign a value to the family labor employed in coffee production and consider it as income (already accounted for in the calculation of net coffee income). Otherwise, it would imply that family labor has no real economic value.

[28] Coffee represents the most important source of income for 63% of active arabica coffee farmers in Mexico: 79% of coffee farmers in Chiapas, 67% in Veracruz, 62% in Oaxaca and only for 46% in Puebla, where coffee is less profitable, and a larger proportion of farmers experience losses in coffee farming.

[29] National poverty and extreme poverty lines are updated monthly by CONEVAL. The study used the poverty lines reported for April 2022: https://www.coneval.org.mx/Medicion/MP/Paginas/Lineas-de-Pobreza-por-Ingresos.aspx

[30] All inactive arabica coffee farmers were not able to afford a basic food bundle.

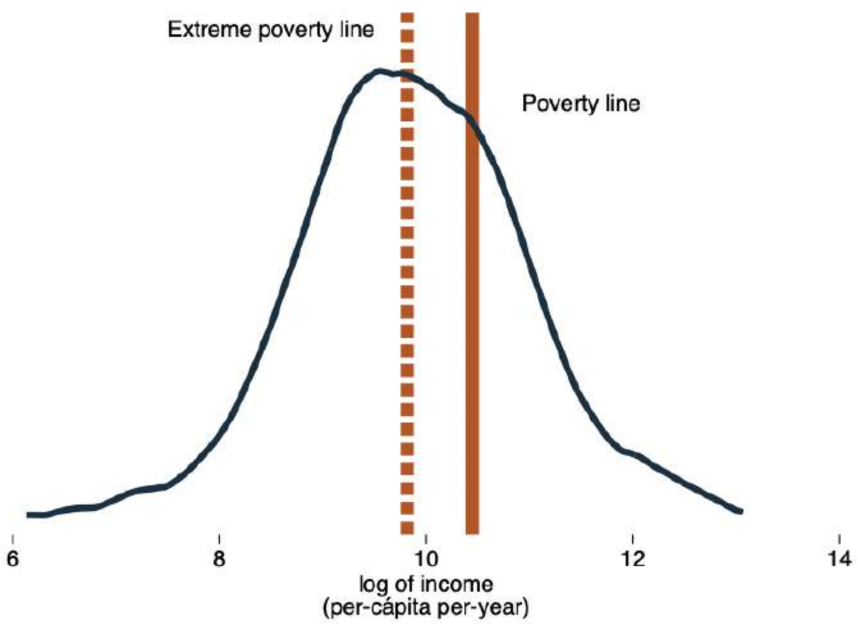
[31] Income from this activity includes both compact area farming and intercropping.

**Table 4.2.1: Total annual household income**

| | State | | | | Average |
|---|---|---|---|---|---|
| | Chiapas | Oaxaca | Puebla | Veracruz | |
| Net income from coffee | 43,619 | 26,737 | 30,583 | 69,586 | 45,962 |
| Other agricultural net income | 3,922 | 6,621 | 13,465 | 9,860 | 8,184 |
| Business net income | 126 | 8,450 | 4,588 | 4,563 | 3,753 |
| Wage Income | 11,296 | 22,618 | 31,136 | 16,910 | 19,043 |
| Opp. Cost of family labor (*) | 7,628 | 9,635 | 13,832 | 17,446 | 12,237 |
| Total Household Income (MXN) | 66,591 | 74,062 | 93,604 | 118,365 | 89,181 |
| Poor (%) | 85% | 81% | 71% | 53% | 72% |
| Extreme poor (%) | 63% | 56% | 45% | 36% | 50% |

The aggregate total annual household income for coffee farmers in Mexico is insufficient for most farmers to make ends meet. In fact, the study shows that approximately 72% of coffee farmers fail to reach the poverty line,[32] and 50% were not able to purchase a basic food basket (See table 4.2.1. above and graph 4.2.1 below). Poorer farmers exhibit less land, have low productivity levels, diversify their sources of income, and have more household members. The latter can be explained as household members produce little yearly income to compensate for the costs of a basic bundle (poverty line).

**Graph 4.2.1: Coffee net income and poverty lines for rural Mexico**




[32] See footnote 19. The study used the poverty lines reported for April 2022: https://www.coneval.org.mx/Medicion/MP/Paginas/Lineas-de-Pobreza-por-Ingresos.aspx

## 4.3 Value chain efficiency

A large percentage of coffee farmers engage in low technology wet processing activities. Technological improvements may lead to better quality and better prices.

Farmers' average cost of production is US $2.62 per kg of GBE, while the prices received averaged US $4.04 (equivalent from fresh cherry production). This results in an average expected profit margin of around 54% for farmers producing fresh cherries.[33]

Most farmers wet-process their coffee on their own farms. Data shows that approximately 70% of coffee farmers engage in some level of wet processing. In Chiapas and Oaxaca, around 95% of farmers have performed at least some wet-processing on their farms, with more than 91% doing it themselves using their own processing equipment. In contrast, about half of the farmers in Puebla and Veracruz have done some wet-processing of their coffee, primarily on their farms. While on-farm wet-processing may provide some mark-up in the price received, it often comes at the expense of quality. For example, only 25% of coffee farmers report adhering to good wet-processing practices. (See Table 4.3.1).

Table 4.3.1: Wet-processing activities within the farm

| | State | | | | Average |
|---|---|---|---|---|---|
| | Chiapas | Oaxaca | Puebla | Veracruz | |
| % Process cherry same day as harvest | 85% | 47% | 90% | 81% | 78% |
| % Wash beans after coffee pulping | 53% | 84% | 61% | 57% | 60% |
| % Rinse beans with clean water after fermentation | 97% | 81% | 82% | 57% | 84% |
| % Monitor fermentation | 66% | 39% | 73% | 51% | 59% |
| % Eliminate empty beans by flotation | 98% | 96% | 94% | 48% | 87% |
| % completed all good wet-processing practices | 17% | 17% | 51% | 32% | 25% |

While wet-processing costs vary depending on factors like the scale of the wet mill operation, the average estimated cost of processing is about US$ 0.96 per kg of GBE. Total wet milling costs encompass various expenses such as transportation, labor, equipment maintenance and depreciation, as well as regular utilities.

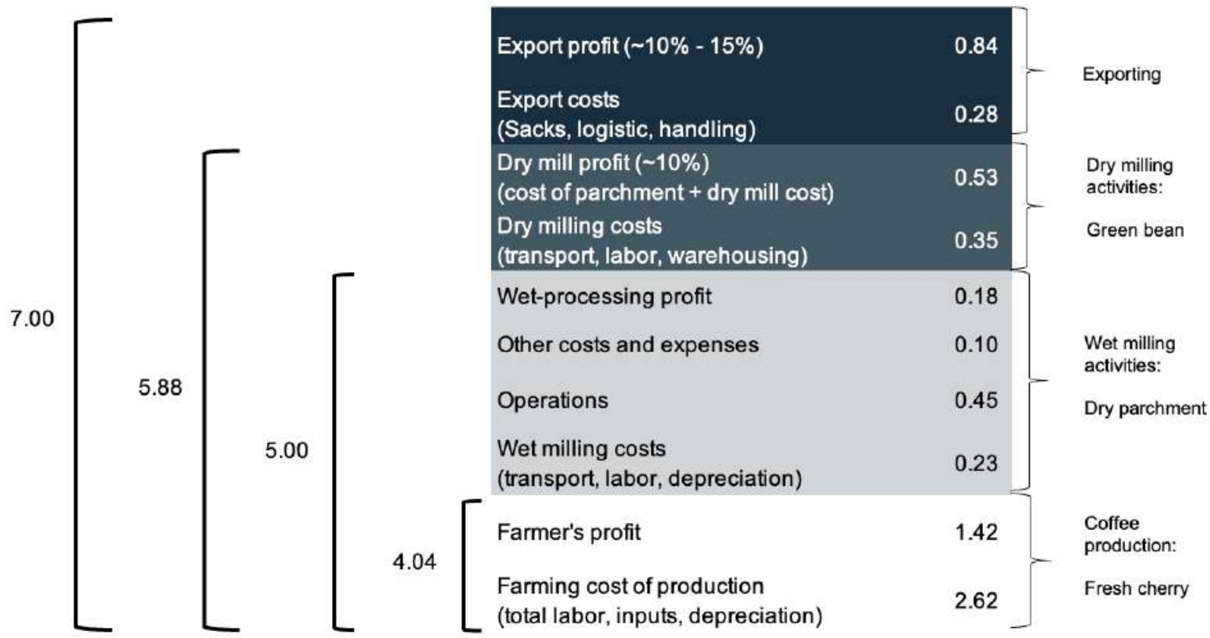
Dry mills buy dry parchment from farmers or their organizations at an equivalent price of US$ 5.00 per kg of GBE. The overall milling costs cover expenses such as transportation,

[33] It is important to note that approximately 40% of total production costs do not require any cash outlay from the farmer. These costs represent the remuneration for family labor (shadow price) and the value of asset depreciation.

labor, warehousing, equipment maintenance, and depreciation. The average estimated cost is US$ 0.35 per kg of GBE, along with a 10% profit margin.

Finally, dry mills supply the green beans to exporters, who incur export costs, including expenses for exporting materials, logistics, handling, among others, totaling approximately US$ 0.28 per kg of GBE. The study considers an export profit of roughly 10% - 15%[34] (See Graph 4.3 below).

**Graph 4.3: Coffee value chain**




There is a limited number of companies and corporations operating within the Mexican coffee value chain. Some of these firms are vertically integrated, operating on a large scale, while some others provide roasted coffee to the growing local markets.

Furthermore, there are significant gains from farmer's vertical integration. To achieve this, it is necessary to promote farmer organizations that offer adequate services to farmers, including wet-processing facilities and training to improve quality productivity and good agricultural practices. These organizations should also help farmers maximize their profit, by effectively selling their coffee. Data shows that only around 18% of coffee farmers are organized, with these organizations primarily providing technical assistance (43%), organizing community projects (23%), and selling coffee (21%).

[34] The data was collected through interviews conducted with 12 different institutions, ranging from cooperative and private wet mills to dry mills, exporters and traders. These interviews were designed to enhance comprehension of the value chain, including its associated costs and profits. For details, see Appendix 6.

# 5. Insights and recommendations

Improvements in technical efficiency may boost productivity while simultaneously lowering production costs.

A technical efficiency model was estimated to assess possible improvements in farmers productivity associated with better input management. The study shows that achieving higher levels of technical efficiency[35] requires an increase in production costs per hectare, which may greatly boost productivity.

Improving technical efficiency primarily hinges on the implementation of good agricultural practices (such as fertilization, soil management, pruning, adequate pest management techniques), appropriate utilization of inputs (in terms of quantity, quality, and timing), and a more productive age of coffee trees. Such activities will have a positive impact on improved productivity and a reduction in production costs per unit of production.

The study shows that farmers in the 3rd quintile of efficiency have an average yield of 9.5 quintals of dry parchment (351 KG of GBE) and a median cost per hectare of MNX 19,732 (US$ 897), which represents a total cost per quintal of dry parchment of MXN 1,998 (or equivalently US$ 2.46 per kg of GBE). Improving efficiency from 0.73 to 0.83 (moving from the 3rd to the 5th quintile of efficiency)[36] is associated with an increase in productivity of 102%, and a 15% decrease in the production costs per quintal of dry parchment. At average prices from the 2021/2022 coffee season (MXN 3875), an average increase in efficiency of 14% returns more than 136% increase in net incomes due to higher productivity levels and lower production costs per quintal (See Table 5.1 below).

**Table 5.1: Efficiency and net income**

| Quintile of efficiency | Yields (QQ of dry parchment per ha) | Costs of production per ha | Cost of production per QQ of dry parchment | Expected net income per ha |
|---|---|---|---|---|
| I < 0.55 | 3.81 | 12,302 | 3,406 | 3,162 |
| II 0.56 - 0.67 | 6.53 | 16,202 | 2,579 | 9,057 |
| III 0.68 - 0.74 | 9.49 | 17,688 | 1,998 | 19,732 |
| IV 0.74 - 0.80 | 14.22 | 23,097 | 1,667 | 32,086 |
| V > 0.8 | 19.16 | 28,803 | 1,704 | 46,649 |

[35] Technical efficiency is the ability of a producer to obtain the maximum production possible from a minimum set of inputs under a specific technology. Technical efficiency is a relative measure as it compares efficiency with the best performers from the sample. For details, please see Appendix 7

[36] We utilized the productivity of the most efficient quintile among farmers with a technical efficiency greater than 0.8. as a reference point, see for more details Table A7.2 in Appendix 7.

Even with considerable improvements in efficiency and significant increases in yields, the resulting boost in coffee net income remains insufficient to significantly reduce poverty.

Removing technical inefficiency from least productive coffee farmers[37] will result in a 129% increase in coffee net incomes due to higher productivity rates (+30%) and lower costs per quintal of dry parchment (-29%). While keeping other sources of farm and non-farm income constant, this leads to a reduction in income poverty from 72% to 57%, and in extreme poverty from 50% to 31%.[38] However, despite the significance of these changes, they are insufficient to eradicate poverty among coffee farmers.

Several factors contribute to the limited impact of reducing technical inefficiencies, but the most critical is the poverty gap. Poor farmers have an average total income that is one-third of the poverty line, so even substantial improvements in yields and reductions in production costs are not enough to lift them out of poverty. (See Table 4.2.1 below)

Table 5.2 Poverty changes associated to improved yields

| State | | Yields (QQ of dry parchment per ha) | Costs of production per ha | Cost of production per QQ of dry parchment | Expected coffee net income per ha | Poverty rate | Extreme poverty rate |
|---|---|---|---|---|---|---|---|
| Chiapas | Status Quo | 11.39 | 19,397 | 2,057 | 26,822 | 86% | 64% |
| | Improved | 13.98 | 23,052 | 1,706 | 54,186 | 63% | 34% |
| Oaxaca | Status Quo | 4.11 | 8,663 | 3,588 | 9,361 | 83% | 63% |
| | Improved | 6.41 | 11,661 | 1,996 | 25,437 | 76% | 47% |
| Puebla | Status Quo | 10.10 | 20,702 | 2,768 | 16,498 | 74% | 48% |
| | Improved | 13.47 | 25,564 | 2,071 | 45,285 | 57% | 26% |
| Veracruz | Status Quo | 13.36 | 23,593 | 2,485 | 28,142 | 54% | 38% |
| | Improved | 17.10 | 29,229 | 1,859 | 62,953 | 36% | 16% |
| Country | Status Quo | 9.97 | 18,294 | 2,677 | 21,007 | 72% | 50% |
| | Improved | 12.96 | 22,583 | 1,890 | 48,056 | 57% | 31% |

Price volatility is the major source of risk for coffee farmers, significantly affecting farmers' decision-making processes. A floor price of MXN 3200 per quintal of dry parchment (US$ 3.93 per kg of GBE) will leave efficient farmers break even.

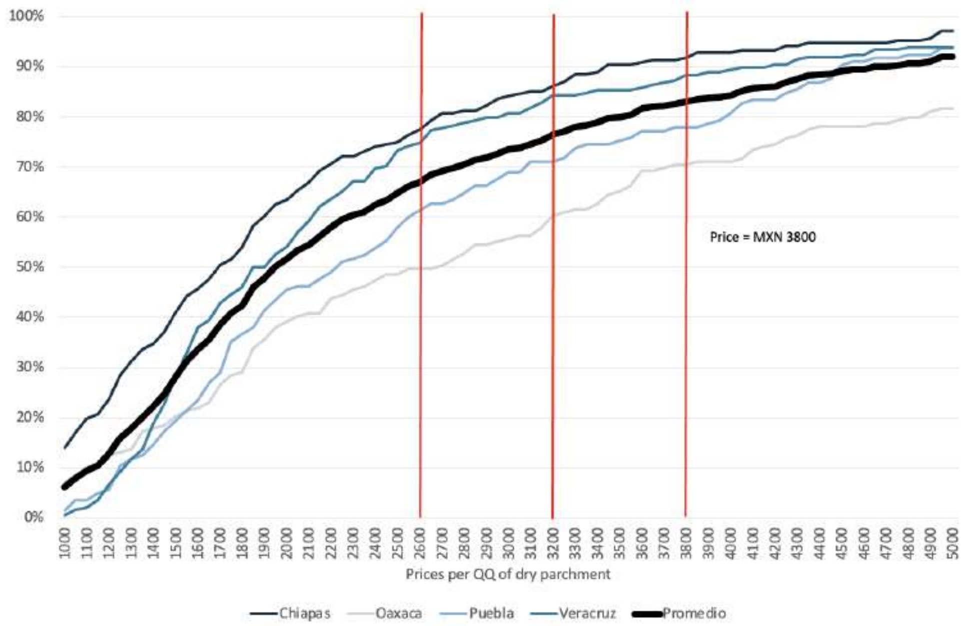
[37] We simulated an increase in coffee yields to the average yield in the community where the farmer belongs.

[38] These figures differ from previous data as it incorporates all arabica coffee farmers, including active and inactive coffee farmers.

Coffee farmers consider price volatility a major source of risk (37%). During the 2021/2022 harvest season, prices were relatively high, averaging MXN 3920 per quintal of dry parchment, leaving 11% of active coffee farmers with negative coffee incomes.

The study ran a price simulation under current cost structure and productivity levels to assess the percentage of farmers who will break even (See Graph 5.1). Data indicates that at a price of MXN 2600 per quintal of dry parchment, 33% of farmers will face negative coffee net incomes; at MXN 3200, about a quarter of coffee farmers will still have negative outcomes; and, at MXN 3800, 17% of coffee farmers will still face negative outcomes.

Graph 5.1 Price simulation and break-even analysis

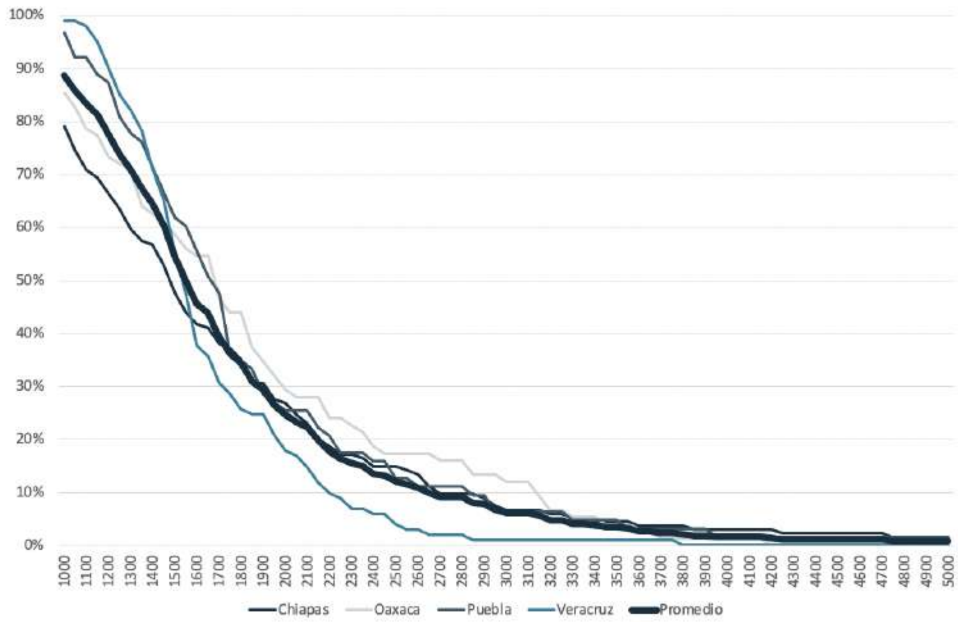



As shown before, coffee farmers are heterogeneous and have heterogeneous outcomes (yields and production costs). In order to define a set of minimum prices under which farmers break even, it is necessary to account for a minimum level of technical efficiency in coffee farming. Such levels will determine the space of analysis as it defines the spectrum of yields and costs for the upper efficiency levels.

In this line of analysis, using data from the 3rd - 5th quintile of the efficiency distribution, the study ran the price simulation again on the percentage of farmers with negative net incomes (See Graph 5.2). Research shows that prices around MXN 2100 per quintal of dry parchment (similar 2023 / 2024 season), will result in 22% of coffee farmers (in the 3rd - 5th quintile of the efficiency distribution) with negative profits (28% in Oaxaca, 25% in Puebla, 23% in Chiapas and 15% in Veracruz). On the other hand, prices around MXN 4000 per quintal of dry parchment (2021 / 2022 season) show only 2% of efficient farmers facing negative outcomes.

The analysis shows that a price of MXN 3200 stabilizes negative outcomes for all states, leaving around 5% of coffee farmers still facing negative profits.

## Graph 5.2 Minimum price for efficient farmers



# 6. Final remarks

1. Efforts to enhance efficiency at the farm level by boosting productivity and reducing production costs, while maintaining other sources of farm and non-farm income constant, could lead to a mild decrease in poverty among coffee farmers. Specifically, the study projects that such improvements could reduce the poverty rate from 72% to 68%, and extreme poverty from 50% to 45% (see Table 5.1 above). Furthermore, enabling farmers to engage in vertical integration and capitalize on various stages of the value chain may yield a substantial increase in income. However, it is important to acknowledge that while these changes are meaningful, they may not be sufficient on their own to completely eradicate poverty among coffee farmers, especially those with smaller operations. It is important to note, that there are other alternatives such as opting for more resistant and resilient improved varieties in order to improve long-run sustainability of coffee production.
2. Promoting investment in Good Agricultural Practices (regenerative practices, fertilizing, pruning), as well as improving management skills (technical efficiency) is crucial, as existing research literature suggests these practices have positive impacts on productivity.
3. Socio-demographic disparities (gender, education, age), highlight the importance of crafting policies and interventions in the coffee farming sector that take into account the unique socio-demographic profiles of farmers (farmer archetypes), particularly female-headed households. Evidence suggests that young farmers are more inclined to adopt new and better practices and are more likely to engage in the agricultural technological revolution, which is critical to productivity enhancement and professionalization of the farming business.
4. One effective strategy for increasing income from coffee farming involves promoting vertical integration. This approach requires efficient farmer organizations willing to improve quality and quantity of production. Farmer organizations should be able to provide adequate and regular training and technical assistance to farmers, but also require adequate equipment to develop high quality wet-processing services to farmers. Poverty prevents farmers from investing in their coffee farms and credit is scarce. This approach leverages the profitability of coffee cultivation and is associated with significantly higher incomes, proving to be a valuable strategy for coffee farmers.
5. Exploring alternative agricultural and non-agricultural sources of income can also play an important role not only improving coffee productivity, but also in expanding opportunities for rural households.
6. Price volatility is a major source of risk and generates uncertainty amongst coffee farmers, especially in a context of climate change with large variation in temperatures and rainfall. By simulating price changes within a set of efficient farmers, the study shows that a floor price of MXN 3200 per quintal of dry parchment will allow efficient farmers to break even, which can be interpreted as a floor price for coffee in Mexico.

# Appendices

# Appendix 1: Sample design

According to SIAP (2021) in Mexico, there are 545 thousand coffee farmers that produce in more than 710 thousand hectares. Sample size was estimated using random sampling for finite population using the formula:

$$n = \frac{Nz_{1-\alpha/2}^{2}\sigma^{2}}{(N-1)e^{2}+z_{1-\alpha/2}^{2}\sigma^{2}} = \frac{Nz_{1-\alpha/2}^{2}c^{2}}{(N-1)\varepsilon^{2}+z_{1-\alpha/2}^{2}c^{2}} \quad (1)$$

Where:

- N represents the total population
- Z is a percentile value of the normal distribution accumulating to the left a probability of $1-\alpha/2$
- σ is the standard deviation of the object of estimation (average cost of production)
- e is the sampling error

Given that the coefficient of variation is the ratio between the standard deviation and the sample mean, we can express the sample size in terms of the coefficient of variation. With a confidence interval of 95%, the value of Z is 1.96, an estimation error of 5.7% and a coefficient of variation of 0.85 for our average cost of production estimate, the resulting sample size is 855.

In order to reduce sample dispersion within all coffee producing states, the study focuses on four states that represent about 85% of the coffee area and 90% of total production, namely Chiapas, Veracruz, Oaxaca and Puebla (See Table A1.1).

**Table A1.1: Coffee production in Mexico and focus states**

| | Total area | | Total production | |
|---|---|---|---|---|
| | (ha) | % Acum | Tons of fresh cherry | % Acum |
| Chiapas | 253,458 | 36% | 384,550 | 41% |
| Veracruz | 145,211 | 56% | 229,849 | 65% |
| Oaxaca | 134,172 | 75% | 85,904 | 74% |
| Puebla | 70,674 | 85% | 149,549 | 90% |
| Guerrero | 45,549 | 91% | 39,133 | 94% |
| Hidalgo | 23,070 | 95% | 29,302 | 97% |
| San Luis Potosí | 16,149 | 97% | 9,802 | 98% |
| Nayarit | 15,297 | 99% | 9,680 | 99% |
| Jalisco | 3,483 | 99% | 4,772 | 100% |
| Colima | 2,720 | 100% | 3,393 | 100% |
| México | 531 | 100% | 640 | 100% |
| Tabasco | 358 | 100% | 421 | 100% |
| Querétaro | 199 | 100% | 60 | 100% |
| Morelos | 28 | 100% | 39 | 100% |
| Total | 710,897 | | 947,092 | |

The study applied a proportional distribution of the sample size, so that each state has a sample size proportional to its participation in total production (See Table A1.2). Municipalities were selected within each state and sample size was distributed proportionally to its participation in total production within each state. Finally, farmers were selected within each district using knowledgeable people in each municipality.

**Table A1.2: Sample size distribution**

| | Sample size | | Municipalities selected | |
|---|---|---|---|---|
| | Sample design | Final sample | Sample design | Final sample |
| Chiapas | 350 | 339 | 14 | 14 |
| Oaxaca | 158 | 179 | 16 | 16 |
| Puebla | 146 | 146 | 10 | 10 |
| Veracruz | 201 | 219 | 16 | 15 |
| Total | 855 | 883 | 56 | 55 |

# Appendix 2: Fieldwork methodology and composition of the final sample

## Indicators & methodology validation process

The Committee on Sustainability Assessment assembled an International Technical Advisory Panel (ITAP), comprising 17 experts from research institutions, economists, coffee specialists, and governmental agencies. The ITAP convened regularly in 2022 and 2023 to validate the indicators and methodologies used in the study, which were essential for deploying the field questionnaire.

## Key components of the survey questionnaire

The survey questionnaire aimed to collect relevant information from farm households. Conducted by INIFAP between December 2023 and April 2024, it focused on the coffee production period of 2021-2022 in Mexico, specifically targeting the departments of Chiapas, Veracruz, Puebla, and Oaxaca, which represent approximately 90% of the country's coffee production.  Covering a broad spectrum of topics, the questionnaire sought insights into various aspects, including:

- Household demographics
- Farm characteristics (such as farm area, land use, land tenure, rentals, and forestation)
- Coffee production (including coffee area, coffee trees (age, variety, production state, slope of coffee fields, location, coffee production and sales)
- Coffee production costs
- Farm equipment and assets
- Actual income sources (including income from sales of coffee, other crops, and livestock as well as wage and business income)
- Access to other services (such as training, credit, producer organization, etc.)

# Fieldwork

### Table A2.1: Final sample

| State | Final sample | Varieties | | |
|---|---|---|---|---|
| | | Arabica | Robusta | Arabica & robusta |
| Chiapas | 339 | 210 | 26 | 103 |
| Oaxaca | 179 | 172 | 7 | 0 |
| Puebla | 146 | 146 | 0 | 0 |
| Veracruz | 219 | 198 | 5 | 16 |
| TOTAL | 883 | 726 | 38 | 119 |

## Table A0.2a: Final sample details (Chiapas)

| State | Municipalities | Final sample | Varieties | | |
|---|---|---|---|---|---|
| | | | Arabica | Robusta | Arabica & robusta |
| Chiapas | Chenalhó | 20 | 20 | 0 | 0 |
| | Chilón | 35 | 35 | 0 | 0 |
| | Escuintla | 28 | 7 | 6 | 15 |
| | Huehuetan | 16 | 3 | 3 | 10 |
| | Huixtla | 15 | 0 | 0 | 15 |
| | Mapastepec | 15 | 3 | 3 | 9 |
| | Motozintla | 48 | 46 | 1 | 1 |
| | Siltepec | 40 | 40 | 0 | 0 |
| | Tapachula | 50 | 0 | 12 | 38 |
| | Tenejapa | 15 | 15 | 0 | 0 |
| | Tila | 22 | 22 | 0 | 0 |
| | Tumbala | 15 | 15 | 0 | 0 |
| | Tuzantán | 5 | 4 | 0 | 1 |
| | Villa Comatitlan | 15 | 0 | 1 | 14 |
| | TOTAL CHIAPAS | 339 | 210 | 26 | 103 |

## Table A0.2b: Final sample details (Oaxaca)

| State | Municipalities | Final sample | Varieties | | |
|---|---|---|---|---|---|
| | | | Arabica | Robusta | Arabica & robusta |
| Oaxaca | Guevea de Humboldt | 10 | 10 | 0 | 0 |
| | Ixtlan de Juarez | 9 | 8 | 1 | 0 |
| | Pluma Hidalgo | 16 | 16 | 0 | 0 |
| | Putla Villa de Guerrero | 10 | 10 | 0 | 0 |
| | San Jose Tenango | 14 | 14 | 0 | 0 |
| | San Juan Bautista Valle Nacional | 15 | 10 | 5 | 0 |
| | San Mateo Piñas | 11 | 11 | 0 | 0 |
| | San Miguel Quetzaltepec | 11 | 11 | 0 | 0 |
| | San Pedro Pochutla | 11 | 11 | 0 | 0 |
| | Santa Catarina Juquila | 9 | 9 | 0 | 0 |
| | Santa Cruz Itundujia | 10 | 10 | 0 | 0 |
| | Santa Maria Yucuhiti | 10 | 10 | 0 | 0 |
| | Santa Maria Chilchotla | 14 | 13 | 1 | 0 |
| | Santiago Lachiguiri | 10 | 10 | 0 | 0 |
| | Santiago Nuyoo | 9 | 9 | 0 | 0 |
| | Santo Domingo Petapa | 10 | 10 | 0 | 0 |
| | TOTAL OAXACA | 179 | 172 | 7 | 0 |

## Table A0.2c: Final sample details (Puebla)

| State | Municipalities | Final sample | Varieties | | |
|---|---|---|---|---|---|
| | | | Arabica | Robusta | Arabica & robusta |
| Puebla | Cuetzalan del Progreso | 19 | 19 | 0 | 0 |
| | Hueytamalco | 16 | 16 | 0 | 0 |
| | Huitzilan de Serdan | 10 | 10 | 0 | 0 |
| | Jalpan | 15 | 15 | 0 | 0 |
| | Jopala | 11 | 11 | 0 | 0 |
| | Tlacuilotepec | 12 | 12 | 0 | 0 |
| | Tlaola | 11 | 11 | 0 | 0 |
| | Tlaxco | 10 | 10 | 0 | 0 |
| | Xicotepec | 20 | 20 | 0 | 0 |
| | Zihuateutla | 22 | 22 | 0 | 0 |
| | TOTAL PUEBLA | 146 | 146 | 0 | 0 |

## Table A0.2d: Final sample details (Veracruz)

| State | Municipalities | Final sample | Varieties | | |
|---|---|---|---|---|---|
| | | | Arabica | Robusta | Arabica & robusta |
| Veracruz | Altotonga | 11 | 11 | 0 | 0 |
| | Atzalan | 21 | 21 | 0 | 0 |
| | Coatepec | 17 | 17 | 0 | 0 |
| | Cordoba | 13 | 12 | 1 | 0 |
| | Cosautlan de Carvajal | 13 | 13 | 0 | 0 |
| | Emiliano Zapata | 19 | 19 | 0 | 0 |
| | Huatusco | 20 | 20 | 0 | 0 |
| | Ixhuatlan del Cafe | 7 | 5 | 2 | 0 |
| | Tenochtitlan | 11 | 11 | 0 | 0 |
| | Teocelo | 10 | 10 | 0 | 0 |
| | Tezonapa | 20 | 3 | 1 | 16 |
| | Tlaltetela | 13 | 13 | 0 | 0 |
| | Totutla | 9 | 9 | 0 | 0 |
| | Xico | 10 | 10 | 0 | 0 |
| | Zongolica | 25 | 24 | 1 | 0 |
| | TOTAL VERACRUZ | 219 | 198 | 5 | 16 |

# Appendix 3: Coffee farmers and their operations

## Key demographics of coffee farmers

**Table A3.1: Coffee farmer demographics (Arabica producers)**

| | State | | | | Gender | | Average |
|---|---|---|---|---|---|---|---|
| | Chiapas | Oaxaca | Puebla | Veracruz | Male | Female | |
| Female HH | 82.4% | 67.4% | 78.8% | 82.8% | | | 78.2% |
| Age HH (years) | 50.2 | 53.9 | 54.1 | 56.4 | 54.4 | 50.4 | 53.6 |
| % below 35 y.o. | 16.7% | 13.4% | 6.8% | 7.1% | 10.9% | 12.7% | 11.3% |
| % older than 65 y.o. | 13.3% | 20.3% | 20.5% | 25.8% | 23.1% | 8.2% | 19.8% |
| % HH living with his / her partner | 73.3% | 73.8% | 75.3% | 60.1% | 78.0% | 42.4% | 70.2% |
| HH Members | 3.6 | 3.4 | 3.3 | 2.9 | 3.4 | 3.0 | 3.3 |
| HH Adult Members (older 18 y.o.) | 2.6 | 2.6 | 2.5 | 2.4 | 2.6 | 2.2 | 2.5 |
| HH Adult Members in agro | 2.1 | 2.1 | 1.9 | 1.7 | 2.0 | 1.8 | 2.0 |
| Education HH (primary level complete) | 62.9% | 67.4% | 72.6% | 69.7% | 68.3% | 65.8% | 67.8% |
| Education HH (secondary level complete) | 30.5% | 34.3% | 40.4% | 41.4% | 35.0% | 41.1% | 36.4% |
| Experience HH (years) | 19.2 | 24.3 | 24.9 | 23.8 | 23.5 | 20.0 | 22.8 |
| HH Members young (18 - 35)[T] | 0.8 | 0.7 | 0.6 | 0.6 | 0.7 | 0.5 | 0.7 |
| % young members working in agro[T] | 66.5% | 55.0% | 48.2% | 48.0% | 58.7% | 44.2% | 56.2% |
| % with secondary level completed[T] | 46.2% | 51.5% | 72.5% | 61.0% | 53.3% | 60.5% | 54.3% |

[T] This indicators focus on household members excluding the household head

# Key farm characteristics

### Table A3.2: Farm characteristics

| | | State | | | | Gender | | Average |
|---|---|---|---|---|---|---|---|---|
| | | Chiapas | Oaxaca | Puebla | Veracruz | Male | Female | |
| Farm area (ha) | | 1.9 | 5.4 | 2.0 | 2.5 | 3.1 | 2.4 | 2.9 |
| % land with title[T] | | 97.0% | 90.4% | 74.6% | 93.7% | 91.5% | 84.6% | 90.0% |
| Land use (In hectares) | Coffee | 1.7 | 1.9 | 1.6 | 2.3 | 1.9 | 1.7 | 1.9 |
| | Fruits | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 |
| | Seasonal crops | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 |
| | Forest | 0.1 | 2.1 | 0.2 | 0.0 | 0.6 | 0.5 | 0.6 |
| | Other | 0.0 | 1.0 | 0.1 | 0.0 | 0.3 | 0.1 | 0.3 |
| % land with coffee | | 92.6% | 68.2% | 87.5% | 94.6% | 85.6% | 89.0% | 86.3% |
| % farmers purchased land in the last 3 years | | 1.0% | 4.7% | 1.4% | 1.0% | 2.3% | 0.6% | 1.9% |
| % farmers rented land to expand operations | | 0.5% | 0.6% | 4.1% | 1.5% | 1.2% | 2.5% | 1.5% |
| % participated in land markets | | 1.4% | 5.2% | 5.5% | 2.5% | 3.5% | 3.2% | 3.4% |

[T] We include any legal document that represents property

# Key characteristics of coffee production

**Table A3.3: Coffee characteristics**

| | State | | | | Gender | | Average |
|---|---|---|---|---|---|---|---|
| | Chiapas | Oaxaca | Puebla | Veracruz | Male | Female | |
| Coffee area (has) | 1.7 | 1.9 | 1.6 | 2.3 | 1.9 | 1.7 | 1.9 |
| Number of plots | 1.3 | 1.5 | 1.3 | 1.5 | 1.5 | 1.3 | 1.4 |
| % coffee planted in flat plots | 3.5% | 4.8% | 21.0% | 15.4% | 10.0% | 12.6% | 10.6% |
| % coffee planted in mild slopes | 64.6% | 57.3% | 61.6% | 60.6% | 62.2% | 57.4% | 61.2% |
| % coffee planted in steep slopes | 31.9% | 37.9% | 17.4% | 24.1% | 27.8% | 30.0% | 28.3% |
| % coffee with 75% + shade | 20.0% | 32.0% | 13.7% | 44.4% | 28.5% | 27.2% | 28.2% |
| % coffee with 40% + shade | 66.2% | 83.7% | 86.3% | 91.4% | 81.7% | 79.7% | 81.3% |
| % coffee with 15% + shade | 95.2% | 97.7% | 97.9% | 97.5% | 97.4% | 95.6% | 97.0% |
| % intercropping with coffee 50% + | 22.4% | 37.8% | 15.8% | 33.3% | 28.0% | 26.6% | 27.7% |
| % intercropping with coffee 25% + | 30.0% | 76.2% | 47.3% | 60.1% | 52.6% | 52.5% | 52.6% |
| % intercropping less than 15% | 43.3% | 10.5% | 46.6% | 32.3% | 33.8% | 31.0% | 33.2% |
| Altitude (m.a.s.l.) | 1,307 | 1,196 | 837 | 1,104 | 1,134 | 1,145 | 1,136 |
| Number of coffee trees per hectare | 3,039 | 1,820 | 2,026 | 2,453 | 2,430 | 2,231 | 2,387 |
| % coffee trees in production | 75.3% | 79.6% | 70.8% | 81.1% | 78.0% | 73.5% | 77.0% |
| % trees aged between 0 - 2 years | 15.9% | 22.1% | 21.1% | 10.2% | 16.5% | 18.3% | 16.9% |
| % trees aged between 3 - 9 years | 51.7% | 43.2% | 58.0% | 68.8% | 55.9% | 54.4% | 55.6% |
| % trees aged between 10 - 15 years | 16.8% | 7.7% | 12.4% | 12.4% | 12.7% | 12.0% | 12.5% |
| % trees aged between 15 - 29 years | 10.7% | 14.4% | 4.9% | 4.3% | 8.6% | 8.8% | 8.7% |
| % trees aged more than 30 years | 5.0% | 12.6% | 3.8% | 4.3% | 6.3% | 6.5% | 6.3% |

# Determinants of coffee tree renovation

This study examines factors influencing coffee tree renovation using a simple linear probability model with clustered errors at the municipality level. It finds that farmer demographics and specific characteristics of coffee farming significantly impact the farmers’ decision to renovate coffee trees. Key insights include:

- Younger farmers have a higher proportion of coffee trees aged between 0 and 2 years. This is a crucial insight, emphasizing the importance of targeting younger producers and educating household members involved in coffee farming about the benefits of tree renovation for productivity improvement.

- Farmers with larger coffee areas are likely to have a larger proportion of recently added coffee trees. It implies that larger farmers are more inclined to do coffee tree renovation, possibly due more economic incentives and financial capability.
- Farmers that have a higher economic dependence on coffee farming, are less likely to invest in coffee tree renovation. Data shows that farmers that have a higher proportion of their farm cultivated with coffee have a lower proportion of young coffee trees.
- Research shows that farmers cultivating coffee at higher altitudes have a lower proportion of new coffee trees in their farms. Also, farmers who hold a larger proportion of old trees and higher tree density are less likely to renovate their coffee trees. Finally, it was observed that coffee farms in Veracruz are less likely to have a large proportion of recently added coffee trees.

**Table A3.4: Determinants of coffee tree renovation**

| | y = % coffee trees aged 0 - 2 years | |
|---|---|---|
| | Ordinary Least Squares with clustered errors at municipality level | Robust regression |
| Age HH | 0.0518** | 0.0523** |
| Female HH | -0.0159 | -0.0019 |
| Number of HH members | 0.0050 | 0.0061 |
| HH completed primary school | -0.0069 | -0.0132 |
| Coffee area (hectares) | 0.0112* | 0.0127*** |
| Altitude (m.a.s.l.) | 0.0000 | -0.0000** |
| % old coffee trees (30+ years) | -0.1414*** | -0.0950*** |
| ln (coffee trees per hectare) | -0.0572** | -0.0276* |
| (Coffee area) / (Farm Area) | -0.0857** | -0.0400 |
| States | | |
| Oaxaca | 0.0196 | 0.0247 |
| Puebla | 0.0138 | -0.0177 |
| Veracruz | -0.0710*** | -0.0710*** |
| Constant | 0.7219*** | 0.3985*** |
| Number of observations | 681 | 681 |
| R-squared | 0.1037 | 0.0929 |

# Appendix 4: Productivity

## Determinants of productivity

The study employs a simple ordinary least squares model (OLS) to assess determinants of productivity. Models A and B analyze the full sample of Arabica coffee farmers, while models C and D focus on the subset of productive farmers. Models A and C estimate OLS models with clustered errors at the municipality level, while models B and D utilize robust regression modeling.

There is a strong correlation between coffee yields and farmers' gender, linked to differences in input usage compared to their male counterparts. Additionally, the study reveals that more empowered farmers typically demonstrate higher productivity levels, suggesting that confidence plays a significant role in the decision-making process aimed at enhancing productivity.

Consistent with existing literature on farm size and productivity, the study finds that smaller coffee farms generally achieve higher productivity. Additionally, a positive correlation exists between the number of trees per hectare and productivity, indicating potential for increasing coffee tree density, especially in states like Oaxaca and Puebla, where the average tree density falls below standards. On average, an 1% in the number of coffee trees per hectare yields a 0.37% increase in average yields.

The study also discovers a strong, positive correlation between the percentage of coffee trees in productive age (3 – 15 years) and tree productivity. Specifically, an increase of 1% in the percentage of trees in the productive age leads to an increase of 0.33% in average coffee yields.

The application of organic or chemical fertilization on coffee farms emerges as crucial for achieving higher yields, especially among active farmers. Shocks and pests also play an important role in determining coffee yields. Farmers experiencing the presence of pests and diseases often report reduced productivity. However, those implementing adequate pest management practices mitigate these negative effects.

The study finds no effect of access to credit, as only 4% of coffee farmers obtain credit. Similarly, there is no direct effect of training or technical assistance on productivity, although training proves essential to adopt good agricultural practices. The study shows that 47% of farmers report receiving training in the last three years prior to the survey, focusing mainly on nursing (59%), agroecological management (58%), pest management

(40%), wet processing (38%), and fertilization (37%). While there was no direct effect of training, Farmers trained in specific topics are significantly more likely to apply these practices on their coffee farms.

Research also shows positive and significant effects of pruning (specifically trimming secondary branches) and holding certification (organic and/or fairtrade) on coffee yields. Conversely, farmers with additional income sources tend to have lower yields, potentially due to reduced incentives for farm work. Finally, the study highlights Oaxaca as the region with the lowest coffee yields among the surveyed areas.

**Table A4.1: Determinants of coffee productivity**

| | y = ln(productivity) | | | |
|---|---|---|---|---|
| | Full sample | | Productive farmers | |
| | (A) Clustered errors at municipality level | (B) Robust regression | (C) Clustered errors at municipality level | (D) Robust regression |
| Female HH | 0.2758*** | 0.3576*** | 0.1869** | 0.1850*** |
| HH young (35 years old or younger) | 0.1789* | 0.0675 | 0.1604* | 0.1177 |
| HH years of experience | 0.0040* | 0.0025 | 0.0028 | 0.0028 |
| HH completed secondary school | 0.0738 | 0.0858 | -0.0102 | 0.0059 |
| Empowerment | 0.0368 | 0.0545*** | 0.0469** | 0.0499*** |
| ln (altitude (m.a.s.l.)) | 0.0030 | 0.0444 | -0.1056 | -0.0834 |
| ln (coffee area) | -0.1976*** | -0.1518*** | -0.1138** | -0.1020** |
| % of coffee planted in steep slopes | -0.1187 | -0.1129 | -0.1133 | -0.1315** |
| ln (coffee trees per hectare) | 0.6274*** | 0.5179*** | 0.3704*** | 0.3788*** |
| % coffee trees in productive age (3 - 15 years) | 0.4951*** | 0.3835*** | 0.3459*** | 0.3102*** |
| Inv. Hiperbolic (value of assets) | 0.0224* | 0.0107 | 0.0061 | 0.0023 |
| Number of resource mgm practices [0 - 6] | -0.0704 | -0.0715 | -0.0625 | -0.0583 |
| Use of nitrogen fixation plants | 0.0622 | 0.1177 | -0.0248 | 0.0032 |
| Use of organic / chemical fertilizer | 0.1550 | 0.1152 | 0.1617** | 0.1284* |
| Credit | -0.1872 | -0.1302 | -0.1278 | -0.1483 |
| Received training or technical assistance | 0.0219 | 0.0428 | 0.0501 | 0.0601 |
| Belong to a producer organization | -0.0795 | -0.0928 | 0.0046 | -0.0164 |
| Pruning (eliminate secondary branches) | 0.2995*** | 0.2373*** | 0.1185* | 0.1283** |
| % of coffee income affected by plague (A) | -0.5844 | -0.4009 | -0.5739* | -0.5351** |
| Number of pest mgm practices [0-10] (B) | -0.0175 | 0.0026 | -0.0111 | -0.0048 |
| Interaction (A x B) | 0.2503* | 0.1363 | 0.2192* | 0.1884* |
| Holds a certification | 0.1250** | 0.1095* | 0.1062* | 0.1052** |
| Has other source of labor income | -0.2303*** | -0.2663*** | -0.1889*** | -0.2060*** |
| States | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Oaxaca | -0.6438*** | -0.7209*** | -0.3373** | -0.3963*** |
| Puebla | 0.1001 | 0.0084 | -0.0131 | -0.0483 |
| Veracruz | 0.2348* | 0.1853* | 0.0739 | 0.0930 |
| Constant | -4.0559*** | -3.3257*** | -0.7790 | -0.9343 |
| R-squared | 0.4545 | 0.4538 | 0.3114 | 0.3027 |
| Number of observations | 680 | 680 | 584 | 584 |

# Appendix 5: Costs of production

## Estimation of production costs

### Household labor

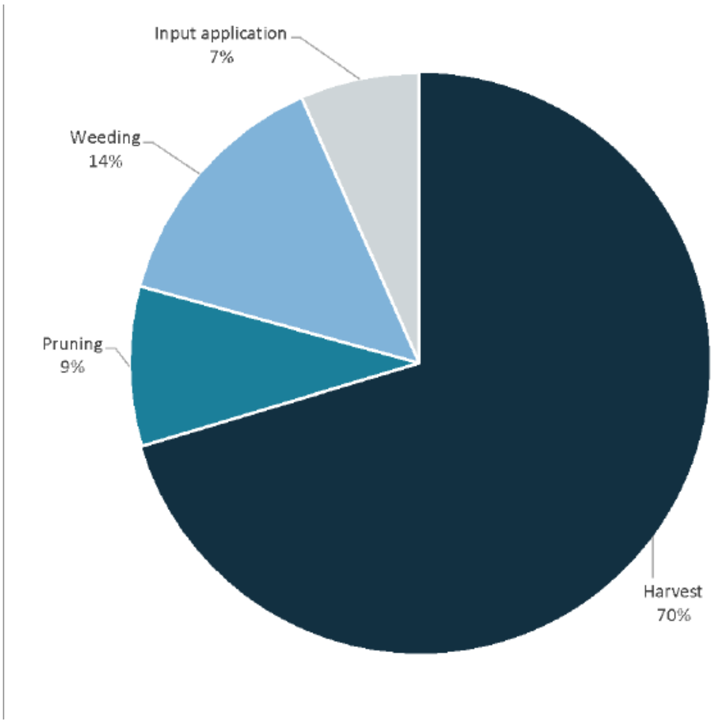
A critical component of any cost of production calculation in agriculture involves estimating household labor and valuing it appropriately. Using survey data, this study compiled farmers' assessments of the number of days worked by each family member involved in coffee farming.[39] Recognizing that farmers' recollection may not be precise, the study anticipated both overestimations and underestimations in their answers. To get an accurate picture of coffee farmers' profitability, the data needed fine-tuning using information from the survey and parameters from secondary sources.[40] This involved estimating family labor for each household using survey data, carefully adjusting for outliers while maintaining average values intact.

Family labor emerged as a significant component of coffee farming. On average, farmers work 57 labor-days on their coffee plots, equating to approximately 34 labor-days per hectare. Most family labor is allocated to harvest and sorting activities (70%), followed by weeding (14%), pruning and stumping (9%), and fertilization and mulching (7%).

[39] Only the following activities were considered: harvest and sorting, weeding, input application, pruning and stumping. Other activities such as nursing and planting seedlings have not been included.

[40] Minimum and maximum parameters were utilized for all activities, drawn from literature providing comprehensive information about production costs for each activity. With these parameters and other relevant survey data (such as coffee area, number of trees, agricultural practices, quantities of inputs applied, etc.), the researchers were able to account for the range of possible values to identify outliers. Subsequently, outlier values were imputed to weighted average medians. For detailed information on the estimation process, please contact info@thecosa.org

**Graph A5.1: Family labor, distribution by activity**




To convert these labor days into a monetary value, the researchers multiplied the total family labor by the opportunity cost of labor in each province.[41] The estimates indicate that the mean value of family labor is MXN 12,237 (US$ 556), representing a total cost of family labor per hectare of MXN 7,496 (US$ 341).

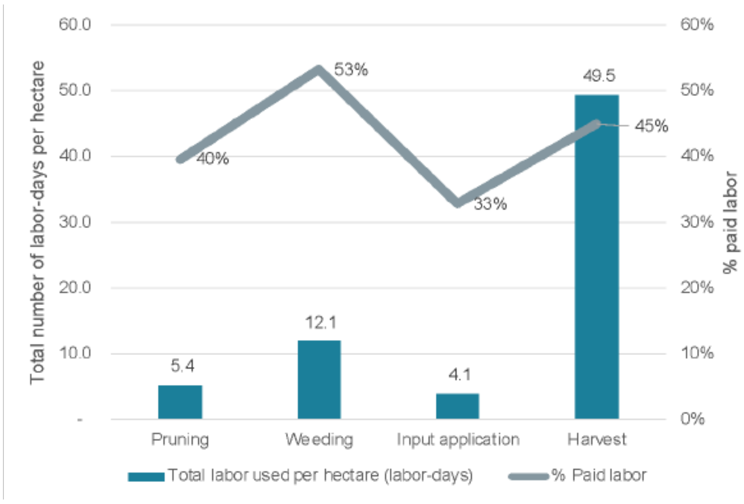
### Paid labor[42]

On average, farmers pay for 66 labor-days on their coffee plots, equating to about 32 labor-days per hectare. Research shows that the mean value of family labor is MXN 12,971 (US$ 590), representing a total cost of family labor per hectare of MXN 7,496 (US$282).

Total labor per hectare amounts to 129 labor-days, distributed similarly to family labor: harvest represents 71% of total labor, followed by weed control (17%), fertilization and mulching (7%), and input application (5%). Paid labor, on average, represents 51.5% of total labor-days employed in coffee production (see Graph A5.2).

[41] Based on survey data, the median daily wage in the Chiapas was MXN 150, whereas in the other provinces it stood at MXN 200. These prices were utilized to estimate the opportunity cost of family labor.
[42] See footnote 18.

**Graph A5.2: Total labor and participation of paid labor**




About 80% of farmers pay for labor. Larger farmers are more likely to pay for labor to complete their activities. Wages range from MXN 100 per labor-day to MXN 400, with an average of MXN 190 per labor-day (see Table A5.1)

**Table A5.1: Wages paid per region**

| | Min | p10 | p50 | p90 | max | Average |
|---|---|---|---|---|---|---|
| Chiapas | 100 | 120 | 180 | 220 | 250 | 170 |
| Oaxaca | 100 | 120 | 200 | 300 | 390 | 200 |
| Puebla | 150 | 180 | 200 | 210 | 300 | 200 |
| Veracruz | 140 | 180 | 200 | 210 | 300 | 200 |

## Depreciation: Replacement value of equipment

Equipment and tools utilized on the farm are a significant component of production costs. To maintain the equipment and tools required for coffee farming over time, there are associated depreciation costs that need to be considered, based on the type of asset. The survey included inquiries about a broad range of assets used in coffee farming, classified according to their replacement time into short, medium, and long-term categories:

**Short-term replacement assets (3 years)**: Spraying equipment, hoes or machetes, pruning implements, harvest hooks, harvest baskets and drying beds and mats.

**Medium-term replacement assets (10 years)**: Irrigation equipment, wheelbarrows, or wagons.

**Long-term replacement assets (15 years)**: Tractors and motorbikes.

To mitigate price distortions arising from differences in quality, equipment condition, and personal judgment, the median valuation for each piece of equipment is utilized. For certain assets, the percentage used specifically for coffee production is also taken into account. To achieve this, the proportion of the total farming area dedicated to coffee cultivation is calculated and applied to the value of assets.

Table A5.2 illustrates that farmers predominately own hoes and machetes (92%), pruning implements (59%), harvest baskets (57%), wheelbarrows or wagons (57%) and processing equipment (21%). The average valuation provided by farmers is considered in the calculation of the total value of assets. As depicted, farmers possess relatively few assets to support their coffee production. The average depreciation cost for farmers is MXN 1,155 (US$ 52.50) which translates to MXN 882 per hectare.

**Table A5.2: Assets, quantity owned and average value**

| | | % own | Average quantity | Average value (MXN) |
|---|---|---|---|---|
| Short term | Spray equipment | 23.0% | 1.31 | 4,381 |
| | Pruning implements | 58.7% | 2.01 | 280 |
| | Hoes, machetes | 92.3% | 2.48 | 420 |
| | Harvest hooks | 11.4% | 1.90 | 79 |
| | Bed or drying mat | 21.5% | 1.73 | 1,589 |
| | Harvest baskets | 56.7% | 2.68 | 268 |
| Medium term | Irrigation equipment | 20.7% | 1.56 | 1,405 |
| | Wheelbarrow or wagon | 57.3% | 1.20 | 1,031 |
| | Processing equipment | 27.1% | 1.26 | 4,011 |
| Long term | Tractors | 0.3% | 1.00 | 20,000 |
| | Motorbikes | 6.9% | 1.09 | 19,860 |

## Value of inputs

Key inputs for coffee production include fertilizers (chemical or organic), foliar fertilizers and pesticides. Farmers were asked whether they used each specific input and, if so, about the quantity used, the number of applications, the amount purchased, and the amount produced on their own farm. For purchased inputs, the price paid has been inquired. Following the methodology of Church and Clay (2016), only the actual costs incurred by the farmer in coffee production (investments) or the opportunity costs they incur are considered.

Around 62% of sampled farmers purchase chemical fertilizers. On average, these farmers purchase 476 kg per hectare, resulting in an average expenditure of MXN 8,483 per hectare (US$ 385.5). Farmers typically use urea (16.7%) and different combinations of N-P-K such as 17-17-17 (16.1%) or 18-12-06 (12.3%). Research also shows that around 29% of coffee farmers use organic fertilization, typically to complement chemical fertilization (with the exception from farmers in Oaxaca which largely use organic fertilization). The most used organic fertilizers are coffee pulp, cow manure and bokashi, which are mostly produced on the farm. On average, farmers who apply organic fertilizer use 808 kg per hectare, resulting in an average expenditure of MXN 1,379 (US$ 63).

Furthermore, the study found that only 11% of farmers applied foliar fertilizers to their coffee, with an average expenditure per hectare of MXN 316 (US$ 14); and that only 7% applied chemical fertilizers to their coffee plantations, spending per hectare on average MXN 595 (US$ 27)

Overall, the average input cost for all farmers is MXN 5,701 (US$ 259). This amount is a combination of cash disbursements and the opportunity cost of inputs (see Table A5.3). Research shows that 74% of farmers use inputs in their coffee farms, with Veracruz having the largest proportion of farmers using inputs (93%), followed by Puebla (79%), Chiapas (69%) and Oaxaca (44%).

**Table A5.3: Value of inputs purchased / produced**

| | | % own | Average quantity | | Average price (MXN) | |
|---|---|---|---|---|---|---|
| Chemical Fertilizer | Urea | 16.7% | 338 | kg | 1,047 | 50kg |
| | 17-17-17 | 16.1% | 424 | kg | 1,027 | 50kg |
| | 18-12-06 | 12.3% | 361 | kg | 919 | 50kg |
| | Yaramila | 11.7% | 241 | kg | 1,232 | 50kg |
| | Average chemical fertilizer | 62.0% | 476 | kg | 1,030 | 50kg |
| Organic Fertilizer | Estiércol de ganado | 6.8% | 777 | kg | 2.0 | kg |
| | Bokashi | 4.8% | 718 | kg | 1.5 | kg |
| | Pulpa de café compostada | 7.5% | 490 | kg | 2.0 | kg |
| | Pulpa de café no compostada | 12.1% | 684 | kg | 2.0 | kg |
| | Average organic fertilizer | 28.9% | 808 | kg | 1.7 | kg |
| Other Inputs | Foliar fertilizer | 11.4% | 1.7 | lt | 187 | lt |
| | Chemical fertilizer | 6.7% | 0.8 | lt | 884 | lt |

## Determinants of coffee production costs

Research identifies several socio-economic and productive variables that significantly influence coffee production costs, explaining the wide variability among farmers.

Contrary to expectations, the study finds no relationship between the size of the coffee area and the production costs per hectare. These results indicate that there is no significant relationship between coffee yields and the size of the coffee growing area.

Altitude correlates positively with production costs per hectare. Farms at higher altitudes face higher production costs per hectare, essentially associated with higher transaction costs to access markets for goods and services (farmers in higher altitudes usually have limited connectivity to markets).

Furthermore, farmers with older trees (aged 30 or above) or younger plantations not yet productive (aged between 0 and 2 years) incur higher production costs per hectare.

Better informed farmers tend to have lower production costs. The farmers who are aware of the quality of their coffee tend to have lower production costs because they tend to be more efficient in their resource utilization. Similarly, farmers who maintain records of their coffee-related activities are more likely to experience lower production costs.

Finally, the study shows that farmers with other sources of income, whether from other agricultural activities or off-farm work, typically have higher production costs per hectare, as the income from these activities is often reinvested into their main source of income, which is coffee.

**Table A5.4: Determinants of production costs per quintal of dry parchment**

| | y = ln(Cost of production per quintal of dry parchment) | |
|---|---|---|
| | Ordinary Least Squares with clustered errors at municipality level | Robust regression |
| Female HH | -0.0237 | -0.0071 |
| HH is young (18 - 35 years old) | -0.1520** | -0.0981 |
| Years of experience | -0.0017 | -0.0013 |
| HH completed primary school | -0.0166 | -0.0217 |
| Number of household members | 0.0210 | 0.0204 |
| Empowerment | 0.0038 | 0.0030 |
| ln (altitude (m.a.s.l.)) | 0.2040** | 0.2056*** |
| % of coffee planted in steep slopes | -0.0398 | -0.0268 |
| ln (coffee area) | 0.0042 | -0.0066 |
| (Coffee area) / (Farm Area) | -0.0358 | -0.0667 |
| % coffee trees recently planted (0 - 2 years) | 0.3060** | 0.2906*** |
| % old coffee trees (older than 30 years) | 0.2364** | 0.2060** |
| Inv. Hiperbolic (value of assets) | 0.0089 | 0.0094 |
| Holds a certification | 0.0332 | 0.0223 |
| Knows the quality of their coffee | -0.1231** | -0.1604*** |
| Record keeping index | -0.0902** | -0.1031*** |
| Number of price information sources used | -0.0539 | -0.0697* |
| Has other source of labor income | 0.1547*** | 0.1444*** |
| States | | |
| Oaxaca | 0.0802 | 0.0651 |
| Puebla | 0.3031*** | 0.2759*** |
| Veracruz | 0.2403** | 0.2358*** |
| Constant | 6.3138*** | 6.6003*** |
| R-squared | 0.1731 | 0.1685 |
| Number of observations | 567 | 567 |

## Marginal productivity of land

The valuation of land, determined by its marginal value, is derived through the estimation of a production function that accurately captures the blend of inputs employed by agricultural producers to generate their agricultural output. In a state of equilibrium and within perfectly competitive markets, the real price of land aligns with the value of the marginal product of land, estimated as the impact on output resulting from a unit change in land ($\Delta Q/\Delta T$).

$Q = f(T, X)$, where $Q$ represents the quantities produced by each farmer; $T$ denotes the land utilized by the farmer; and $X$ represents a matrix encompassing all other inputs utilized in coffee production. Through the estimation of the production function, the following formula is derived:

$PM_gT = \left(\frac{\Delta Q}{\Delta T}\right) = P_t$, where $PM_gT$ is the marginal productivity of land, and $P_t$ stands for the annual rental price of land. In the context of a Cobb-Douglas production function, $P_t$ is the coefficient for land T.

## Investment profile and coffee productivity

### Table A5.5: Investment and productivity

| | Coffee productivity (in quintals of dry parchment per hectare) | | | | | |
|---|---|---|---|---|---|---|
| | Inactive (< 2) | Quintil I (2 - 4.3) | Quintil II (4.4 - 7.2) | Quintil III (7.3 - 10.7) | Quintil IV (10.8 - 16.1) | Quintil V (16.3 - 70.0) |
| Coffee area (has) | 2.06 | 2.11 | 1.70 | 1.63 | 1.61 | 2.20 |
| Coffee trees per hectare | 1,527 | 2,017 | 2,133 | 2,720 | 2,750 | 3,026 |
| % nitrogen fixation plants | 10% | 26% | 31% | 22% | 25% | 32% |
| % using natural / chemical fertilization | 50% | 64% | 62% | 71% | 80% | 88% |
| % using chemical fertilization only | 14% | 42% | 51% | 63% | 74% | 81% |
| kg of fertilizer per hectare | 130 | 274 | 246 | 375 | 440 | 547 |
| Total labor per hectare (excludes harvest labor) | 15 | 18 | 22 | 23 | 22 | 23 |
| Ratio of household labor / total labor | 61% | 59% | 60% | 51% | 49% | 39% |
| Inv. Hiperbolic (Value of agricultural assets) | 8.68 | 9.35 | 9.33 | 9.50 | 9.25 | 9.89 |
| % trees aged between 0 - 2 years | 28% | 22% | 16% | 13% | 15% | 10% |
| % trees aged between 3 - 15 years | 52% | 57% | 69% | 75% | 71% | 82% |
| % trees aged more than 30 years | 7% | 11% | 9% | 3% | 5% | 3% |
| % certified | 7% | 6% | 7% | 8% | 11% | 19% |
| % know quality of their coffee | 14% | 15% | 16% | 13% | 20% | 22% |
| Index of record keeping | 2.81 | 2.62 | 2.51 | 2.50 | 2.56 | 2.61 |
| Number of sources of price information | 1.31 | 1.23 | 1.23 | 1.32 | 1.31 | 1.34 |
| % with other sources of income | 83% | 78% | 71% | 57% | 60% | 56% |
| % with savings | 15% | 22% | 30% | 30% | 32% | 43% |

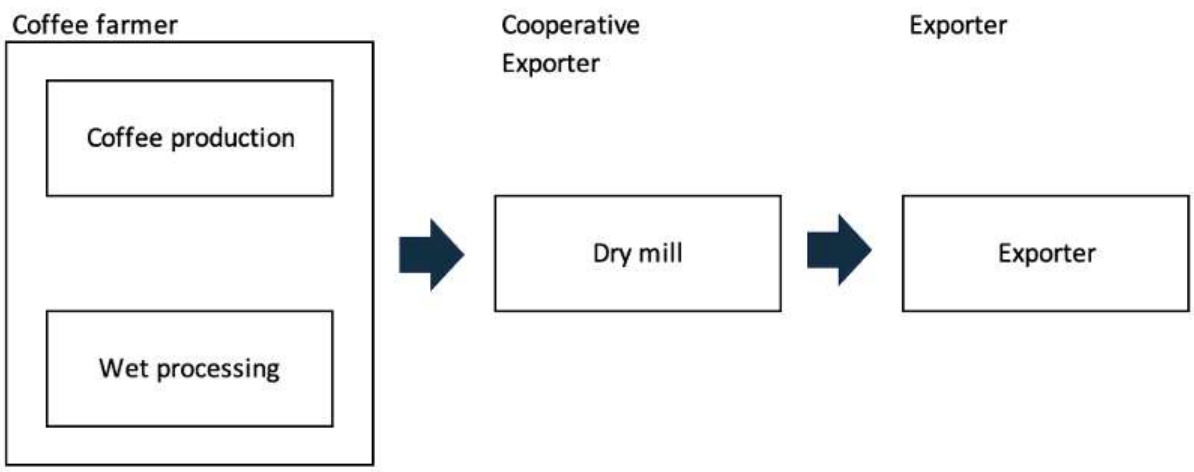
# Appendix 6: Value chain efficiency

The coffee supply chain in Mexico involves multiple stakeholders, including farmers, cooperatives, wet mills, processors/ dry mills, and exporters, each contributing to the value creation within the coffee value chain. By comprehending the intricacies of the coffee value chain, stakeholders can pinpoint bottlenecks and opportunities to ensure equitable distribution of benefits among all participants, particularly smallholder farmers.

## Methodology & sample design

To evaluate the relative efficiency of the value chain, semi-structured interviews were conducted with key stakeholders in the value chain. To define stakeholders, the research team considered the various stages of coffee processing as defined by Espíndola & Trewick (2020), identifying a diverse subset of direct actors within the coffee value chain in Mexico (see Graph 1).

**Graph A.6.1: Mexican Coffee Value Chain**




With the objective to define the interviews to evaluate the coffee value chain in Mexico, the study considered to find different actors operating within the states of Chiapas, Oaxaca, Puebla or Veracruz. A total of 12 interviews were conducted that provided different perspectives of the coffee value chain in Mexico.

**Table A.6.1: Interviews**

| Role in the value chain | Interviews |
|---|---|
| Cooperative | Unión Regional Huatusco<br>Cooperativa Otilio Ruiz |
| Producer and trader | Oaxaca (1)<br>Puebla (1) |
| Farmers’ organizations | ANICAFE<br>AMECAFE |
| Overall value chain | Nestlé<br>Bola de Oro |
| Stakeholders | Brota Café<br>Fondo para la Paz |
| Roaster and trader | Motor de la Sierra<br>Sierra Mágica |

# Appendix 7: Technical efficiency

The applied research model builds on the work proposed by Aigner, Lovell, and Schmidt (1977), who suggest calculating technical efficiency based on the estimation of a stochastic production frontier, assuming that the production process is subject to both a composite error term that captures both the random effects of the environment and technical inefficiency.

In this model, the error term is composed of two distinguishable random disturbances with different characteristics that deviate the producer from obtaining the maximum possible production volume. One random disturbance (U) captures the uncontrollable effects on producers such as favorable or unfavorable events, luck, weather, measurement and observation errors, among others; on the other hand, a non-negative disturbance (V) captures effects controllable by the producer such as crop management, employee effort, adequate combination of factors, at the right time in the right amount, among others, which are directly associated with technical inefficiency. Thus, we propose a model of the form:

- $Y = f(X) \exp(U_i - V_i)$, where Y is the observed production, X is a matrix of inputs used in production, U is a random disturbance with zero mean; and V is a non-negative disturbance capturing effects controllable by the producer and directly associated with technical inefficiency. Thus, we define technical efficiency as:
- $TE_i = Y_i / Y^*_i$, where $TE_i$ is the technical efficiency; and $Y_i$ is the maximum possible production value of individual i.
- The model assumes that the idiosyncratic errors $V_i$ are i.i.d random variables following a normal distribution $\sim N(0,\sigma^2_V)$ and are independent of $U_i$.

To overcome potential heteroscedasticity problems associated with specific producer factors and their production units, it is necessary to model the errors (Caudill and Ford, 1993; Caudill et al., 1995). The inefficiency component is modeled based on variables $Z_i$ that allow to explain limitations in the allocation of producers' resources and that are associated with management, as well as socio-economic characteristics; and agroecological variations that affect their production. For the random component, typically scale variables $Q_i$ are included to correct potential heteroscedasticity biases:

- $\sigma^2_V = \exp(Z_i;\epsilon)$
- $\sigma^2_U = \exp(Q_i;\theta)$

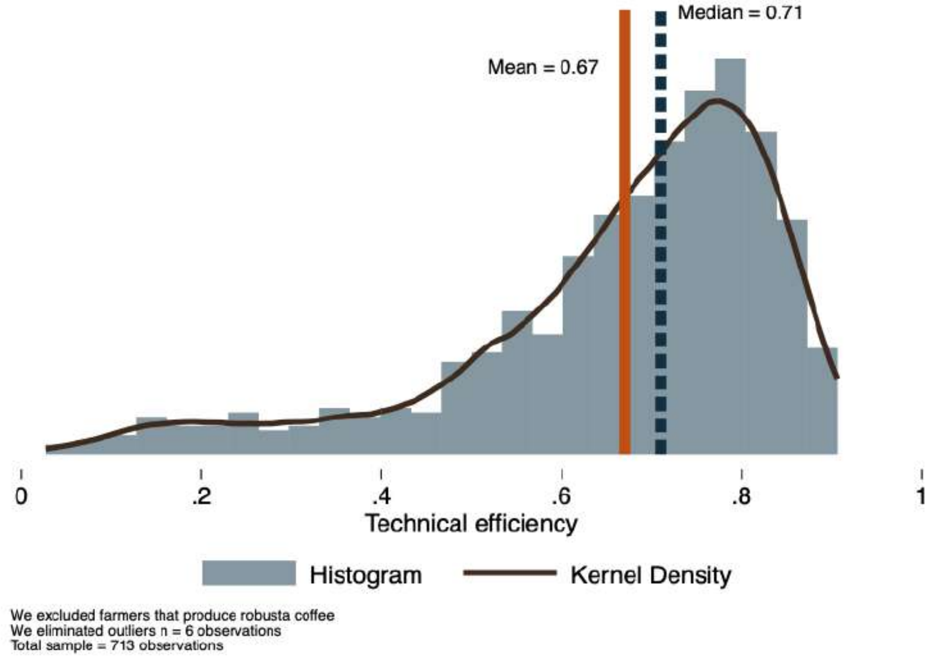
**Table A7.1: Technical efficiency model**

| | | | | | | |
|---|---|---|---|---|---|---|
| Stochastic Frontier Analysis | | | | Number of obs | | 713 |
| Cluster errors at the municipality level | | | | Log likelihood | | 461 |
| | | | | Prob > chi2 | | 0.0000 |
| Dep: Inverse hiperbolic total production (qq of dry parchment) | | | | Log pseudolikelihood | | -791.5159 |
| | **Coefficient** | **Robust S.E.** | **t** | **P > \|t\|** | **[95% Confidence Interval]** | |
| Coffee area* | 0.7738 | 0.0970 | 7.97 | 0.000 | 0.5836 | 0.9640 |
| Fertilizers (kg)* | 0.0679 | 0.0158 | 4.29 | 0.000 | 0.0369 | 0.0989 |
| Non harvest total labor (days)* | 0.1642 | 0.0634 | 2.59 | 0.010 | 0.0399 | 0.2886 |
| Ratio (farm labor) / (total labor) | -0.3734 | 0.0933 | -4.00 | 0.000 | -0.5561 | -0.1906 |
| % Coffee trees aged 3 - 15 years | 0.2288 | 0.1267 | 1.81 | 0.071 | -0.0196 | 0.4771 |
| Estado | | | | | | |
| Oaxaca | -0.7591 | 0.1250 | -6.07 | 0.000 | -1.0042 | -0.5140 |
| Puebla | -0.0798 | 0.0980 | -0.81 | 0.416 | -0.2719 | 0.1123 |
| Veracruz | 0.1151 | 0.1391 | 0.83 | 0.408 | -0.1576 | 0.3878 |
| Constant | 1.6971 | 0.3016 | 5.63 | 0.000 | 1.1059 | 2.2883 |
| Variance of technical efficiency | | | | | | |
| HH is female | -0.9230 | 0.3429 | -2.69 | 0.007 | -1.5951 | -0.2509 |
| HH is young (< 35) | -0.7703 | 0.5805 | -1.33 | 0.185 | -1.9081 | 0.3674 |
| Resource management practices | -0.6963 | 0.3436 | -2.03 | 0.043 | -1.3698 | -0.0228 |
| Farmer is certified | -2.4318 | 1.7120 | -1.42 | 0.155 | -5.7872 | 0.9237 |
| % Coffee trees aged 0 - years | 2.0715 | 0.7738 | 2.68 | 0.007 | 0.5550 | 3.5880 |
| Variance of random error | | | | | | |
| Ratio (coffee area / farm area) | -0.8430 | 0.3575 | -2.36 | 0.018 | -1.5437 | -0.1423 |
| Wealth* | 0.0597 | 0.0388 | 1.54 | 0.123 | -0.0162 | 0.1357 |

* Note: We applied the inverse hyperbolic function to reduce the influence of outliers

Results derived from this model, indicate an average efficiency rating of 0.67, underscoring substantial potential for enhancement within Mexican coffee farming operations, with significant effects in output. Notably, the research analysis reveals considerable heterogeneity in technical efficiency levels across Mexican coffee farmers, as depicted in Graph A7.1.

**Graph A7.1: Technical efficiency distribution**




After assessing the determinants of technical efficiency[43] research shows that younger male farmers tend to be more efficient. Notably the adoption of Good Agricultural Practices (GAP) such as soil and fertility management or the ones derived from certification processes. We also found that farmers with a larger number of recently planted trees are less efficient or conversely, having a larger number of productive trees positively and significantly affect efficiency.

[43] Please note that a negative sign indicates reduced variance. In a non-negative distribution, decreased variance is linked to higher levels of efficiency (as evidenced by a lower value of Vi).

# List of Abbreviations

| | |
|---|---|
| **CoP** | Costs of Production |
| **COSA** | The Committee on Sustainability Assessment |
| **CWS** | Coffee Washing Station |
| **FOB** | Free on Board |
| **GAP** | Good Agricultural Practices |
| **GBE** | Green Bean Equivalent |
| **GIZ** | Deutsche Gesellschaft für Internationale Zusammenarbeit |
| **HLC-L4D** | Highlands Centre for Leadership and Development |
| **ICO** | International Coffee Organization |
| **NPK** | Nitrogen- Phosphorus- Potassium |
| **OLS** | Ordinary Least Squares model |
| **SADER** | Secretariat of Agriculture and Rural Development |
| **TWS II** | Technical Work Stream on Market Transparency |

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