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Research Article

Assessments on Pre and Post Coffee Harvesting Technologies in Southwestern Oromia

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Abstract

Based on the survey data results, Coffee is a vital cash crop in Southwestern Oromia, playing a significant role in the region's economy and the livelihoods of household farmers. Despite a long history of coffee production in southwestern Oromia, its production declined due to improper pre- and post-harvest handling practices. Assessing pre- and post-harvesting technologies is a significant issue. The purpose of this study was aimed at assessing pre- and post-coffee harvesting technology status and its main challenges in southwestern Oromia. The study was conducted in Jimma, Bunno Bedelle, and Ilu Abba Bora zones of six selected districts. During the assessments, focus group discussions and key informant interviews with farmers and experts used both purposive and simple random techniques. Descriptive statistics were employed to analyze the collected data. The cultivable land size for coffee growers varies, with most having between 0.12 and 5.5 hectares. This study assessed various technologies used in the area. Pre-harvest technologies such as improved coffee varieties, hole digging and weeding, pruning technology as well as post-harvest technologies, wet and dry processing technologies, drying and storage technologies, to enhance coffee quality. To improve the quality, efficiency, and sustainability of coffee production, the introduction of appropriate pre- and post-harvest technologies can significantly benefit coffee producer farmers in southwestern Oromia.

Keywords

Pre-harvest, Post-harvest, Technology, Southwestern Oromia

1. Introduction

Ethiopia, the birthplace of coffee, is Africa’s largest coffee producer and the world’s fifth largest exporter of Arabica coffee [1]. Coffee is the main cash crop in Ethiopia, and about 95% is produced by smallholding farmers [3]. Coffee in Ethiopia is more than an agricultural product; it is a cultural symbol. Many Ethiopian farmers are involved in small-scale coffee farming, and coffee ceremonies are integral to social and cultural life, showcasing Ethiopia's deep connection to its coffee heritage.

The sector contributes about 4–5% to the country’s GDP and creates job opportunities [4]. In Ethiopia, 764863.16 ha of land was allocated for coffee production and 494574.36 tones were obtained in 2018/19 Meher Season (CSA, 2019). The two regions contribute for about 99% of the total coffee production (64% from Oromia, 35% from SNNP) and the remaining 1% comes from Gambella regional states [2].

Oromia is one of Ethiopia’s largest and most important coffee-producing regions, playing a pivotal role in the country's coffee economy. Coffee is an integral part of the cultural, social, and economic fabric of the Oromia region. The Oromia

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region has a huge potential for coffee production with more than 3 million hectares suitable for coffee production. But only less than 25% of the total potential lands are currently under coffee production [5]. Coffee farming is the primary income source for millions of people in Oromia, especially smallholder farmers. The region is the backbone of Ethiopia's coffee export industry, which is the country's largest export product. It also provides jobs in processing, transportation, and export industries. Coffee is a major contributor to Ethiopia's economy, and the Oromia region plays a crucial role.

Southwestern Oromia zones are the potential coffee-growing zones, and the share of land allocated for coffee in these areas is more than 69 percent [3]. This shows that coffee is the primary source of income for the study area household farmers. The Southwestern Oromia region is one of the most important coffee-producing areas in Ethiopia, known for its diverse coffee varieties and the high quality of beans it produces. Coffee farming in this region is deeply ingrained in the culture and economy of the local communities. Southwestern Oromia is home to some of Ethiopia's most prized coffee-growing zones, including Jimma, Ilu Abba Bora, and Bunno Bedelle, which are celebrated for their rich coffee culture and high-quality beans. Coffee is an integral part of daily life and culture in Southwestern Oromia, where it is consumed in homes and communal coffee ceremonies [6, 9].

Coffee is often grown under the canopy of indigenous trees, contributing to biodiversity and sustainable farming practices. Coffee cultivation in Southwestern Oromia is largely smallholder-based, with farmers typically owning small plots of land where coffee is cultivated alongside other crops, such as bananas, maize, and vegetables, which provides supplementary income and food security for farming families [9]. Farmers in Southwestern Oromia use manual harvesting, with workers picking only ripe cherries. The harvesting period typically starts from October to January, depending on the altitude and specific local conditions. Coffee farming in this area follows traditional methods combined with modern techniques, and pre- and post-harvest technology are crucial for maintaining the quality and increasing the profitability of coffee [7, 8].

Southwest Oromia, one of the most prominent coffee-producing areas, produces high-quality coffee varieties. However, the status of coffee pre- and post-harvesting technology and challenges that hinder it was not studied in the study area. Studies on coffee production were less focused on pre- and post-coffee harvesting technologies [10, 11]. For instance, previous studies were focused on coffee production, productivity, its marketing systems, and the value chain in the study area. To address this gap, a study was conducted in selected districts of Jimma, Ilu Abba Bora, and Bunno Bedelle zones with the objective to assess the status of coffee pre- and post-harvest technologies and to identify existing constraints and opportunity of coffee harvesting technologies.

2. Research Methodology

2.1. Description of Study Area

This study was carried out in selected districts of Jimma (Gera and Gomma), Ilu Abba Bora (Hurrumu and Yayyo), and Bunno Bedelle (Cora and Bedelle) zones. In Southwestern Oromia, they are known for coffee production, processing, and marketing. The region is home to rainforests, biodiversity hotspots that host various endemic plant and animal species. Southwestern Oromia is part of the East African Coffee Belt, renowned for its production of Arabica coffee. The area features dense vegetation, including wild coffee forests, which are vital for genetic diversity in coffee species. The topography of the region includes highlands, plateaus, and valleys, with elevations ranging from approximately 1,200 to over 2,700 meters above sea level. It has a tropical highland climate, with moderate to high rainfall ranging between 1,200 mm and 2,500 mm annually. Temperatures vary with altitude, generally ranging from 15 ℃ to 25 ℃. Soil: Fertile soils, particularly Nitosols, are ideal for coffee cultivation.

Generally, Southwestern Oromia is an ecologically rich area in Oromia, playing a vital role in the country's agricultural economy, particularly in coffee production. The area is characterized by its unique geography, diverse culture, and significant contribution to Ethiopia's economic and environmental landscape.

2.2. Data Type and Source of Data

Both primary and secondary data sources were used to collect quantitative and qualitative data. Primary data on demographic characteristics, socioeconomic and institutional factors, and other relevant data assumed to meet the objective of the study were collected from randomly selected farm households in the study district. Primary data was collected using a structured questionnaire that was administered by the team of researchers. The questioner was designed and pretested in the field for its validity and content and to make the overall improvement of the study in line with the objectives of the study. While secondary data were collected from different published and unpublished sources, such as regional offices of agriculture, district agricultural offices, and kebele development agents, were consulted to generate relevant data for the study.

2.3. Sampling Technique and Sample Size

In order to meet the objective of any study, determining the appropriate sample size and method of size determination is crucial. Accordingly, three-stage random sampling was employed to select respondent households. In the first stage, study districts were purposively selected for their high potential for coffee production and the intention of the project objective. In the second stage, from each district, three cof-

fee-producing kebeles were based on their coffee production potential and accessibility. In the third stage, given a fresh list of households in the respective kebeles, using a systematic random sampling technique with probability proportion to sample size total of 320 coffee producer farmers were selected randomly.

Based on population size, sampling error, confidence level, and time available sample size was determined by using TaroYamane (1967) formula; with 95 percent confidence interval.

$$n = \frac{N}{1+N(e)^2}$$

Where, N is population size, n is sample size and e is the level of precision.

2.4. Data Collection

Prior to conducting the survey, the structured questioners were tested at selected coffee-producing sites. To collect the required data, we also formed focus group discussions and key informant interviews. These groups included different stakeholders such as coffee-producing farmers, zonal and woreda experts, and development agents. The discussions covered topics such as the general existing pre- and post-coffee harvesting practices, mechanization technology needs, types of farm operations used, perceptions, and constraints.

A semi-structured questionnaire with both close-ended and open-ended questions was set to collect primary data. Secondary data were also collected. To develop the questionnaire, in-depth interviews were conducted with farmers, government offices, DAs, and key informants. Then, coffee producers were interviewed to point out their views on pre- and post-harvest technology as well as related problems on coffee quality in the zones. Additionally, focus group discussions were held with farmers to strengthen and cross-check the data obtained from different stakeholders in selected survey areas. The survey was supplemented by experts' knowledge.

2.5. Method of Data Analysis

The collected data were analyzed using descriptive statistics. Descriptive statistics such as mean, standard deviation, frequency, percentage, and graph were used to describe the different categories of sample units with respect to different socioeconomic characteristics.

3. Result and Discussions

3.1. Socioeconomic Characteristics of Coffee Producers Households

The total sample size of household respondents interviewed during the survey was 320. From the total respondents, 90.3% were male-headed households, and the rest were female-headed. Male-headed households have better access to information than female households, which helps in the adoption of improved agricultural technologies. The education level of sampled household heads' indicated that 67.83% of households were literate while illiterate were (32.17%). According to the survey result, about 52.73% of smallholder coffee producer households had access to extension services in the study areas. Access to credit service is an important issue in coffee production. The survey result revealed that about 57.83% of household respondents had no access to credit services that affect coffee production technology in the study areas.

Table 1. *Summary statistics of sample respondent households (dummy variables).*

Variables	Category	Frequency	Percentage
Sex	Male	289	90.3
	Female	31	9.7
Education of household heads	Illiterate	103	32.17
	literate	2017	67.83
Access to Credit services	Yes	136	42.62
	No	184	57.38
Access to extension services	Yes	169	52.73
	No	151	47.27

Source: Computed from survey data result, 2024

The survey revealed that the average age of coffee producers in the study areas was 48.76 years, with a minimum and maximum age of 21 and 72 years. The average family size was 6 persons per household; it was suggested most households have enough family labor to participate in the coffee production. The majority of coffee production in the study area comes from smallholder farmers, who typically own small plots of land. The average landholding size was 2.87 hectares, with a minimum .25 hectares and a maximum of 7.25 hectares of landholding. Coffee producers have an average of 28.52 years of experience in coffee production, making the sub-sector older compared to other areas. The average coffee land owned by households was 1.96 hectares.

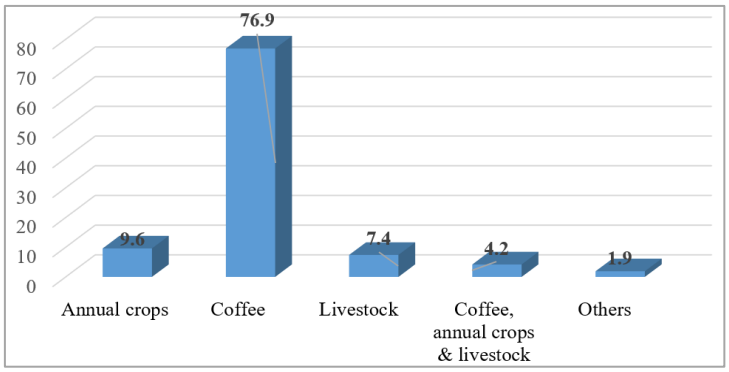
Table 2. *Summary statistics of sample households (continuous variables).*

Continuous variables	Mean	SD	Min	Max
Age	48.76	13.56	21	72
Family size	5.71	2.14	2	13
Experience	28.52	13.82	3	50
Land holding	2.87	2.25	.25	7.25
Coffee land	1.96	1.64	.12	5.5
Age of coffee tree	20.52	11.11	2	55

Source: Computed from survey data result, 2024

3.2. Main Source of Income of Small Holder Household Farmers

In many areas of study, coffee is grown alongside other crops such as bananas, maize, vegetables, and ensets as part of an agroforestry system. This reduces soil erosion, provides additional income, and creates a more sustainable farming environment. Survey results showed that the primary source of income of the respondent household was 76.9% from coffee farming, while the remaining was generated from other sources as shown in the below (Figure 1).



Source: Computed from survey data result, 2024

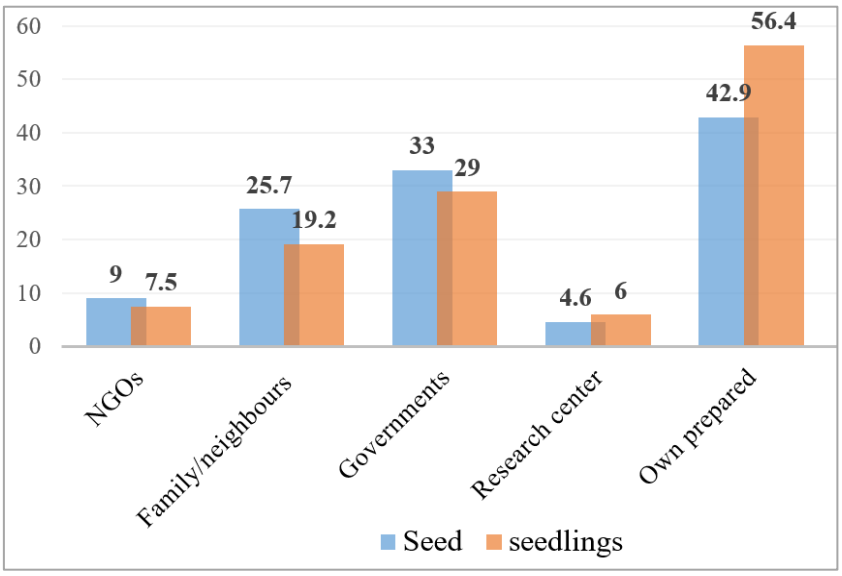
Figure 1. *Main source of income of smallholder farmers.*

3.3. Source of Coffee Planting Material in the Study Area

Seeds and seedlings are two planting materials for coffee production that have been distributed to producers. The main source of seed and seedlings was the district agricultural office. Accordingly, the result of the survey revealed that 42.9% and 56.4% of households got seed and seedlings from the agricultural office. Own-prepared gifts and NGOs were also the sources of the planting materials, respectively.

Research centers like JARC supply seedlings during the

establishment of demonstrations and the scaling up of improved coffee technologies, and NGOs like Techno Serve and Feed the Future have made great contributions to improved coffee variety seed and seedling distributions in the study area (Figure 2).



Source: Computed from survey data result, 2024

Figure 2. *Source of Coffee Planting Material.*

3.4. Sources of Information about Coffee Production Technology in the Study Area

Information is the basic tool to transfer agricultural technologies. Different bodies were provided information about coffee production technology and techniques for the farmers in the study area. Based on the survey result, 52% of household farmers got information from the agricultural office. The research center contributes its share in providing information for 8.44% of respondent households (Table 3).

Table 3. *Sources of information about coffee production technologies.*

Sources	Occurrence	Percentage
NGO	19	5.93
Research centers	27	8.44
Agri. Office	166	52
Radio/TV	22	6.87
Neighbor farmer	111	34.7

Source: Computed from survey data result, 2024

3.5. Farmers' Perceptions on Change in Coffee Production Technology in the Study Area

Survey results revealed that the majority of coffee producers, 57% of the sample households, replied that there was an increase in coffee production coverage over the last 5 years, while about 33.2% of coffee producer households responded that there was no change in the coffee production technology coverage in the study area (Table 4).

Table 4. *Farmers' perceptions on production technologies.*

Variables	Response	Percentage
Change in coffee production technology	Decrease	7.3
	No change	33.2
	Increase	57
	No response	2.5

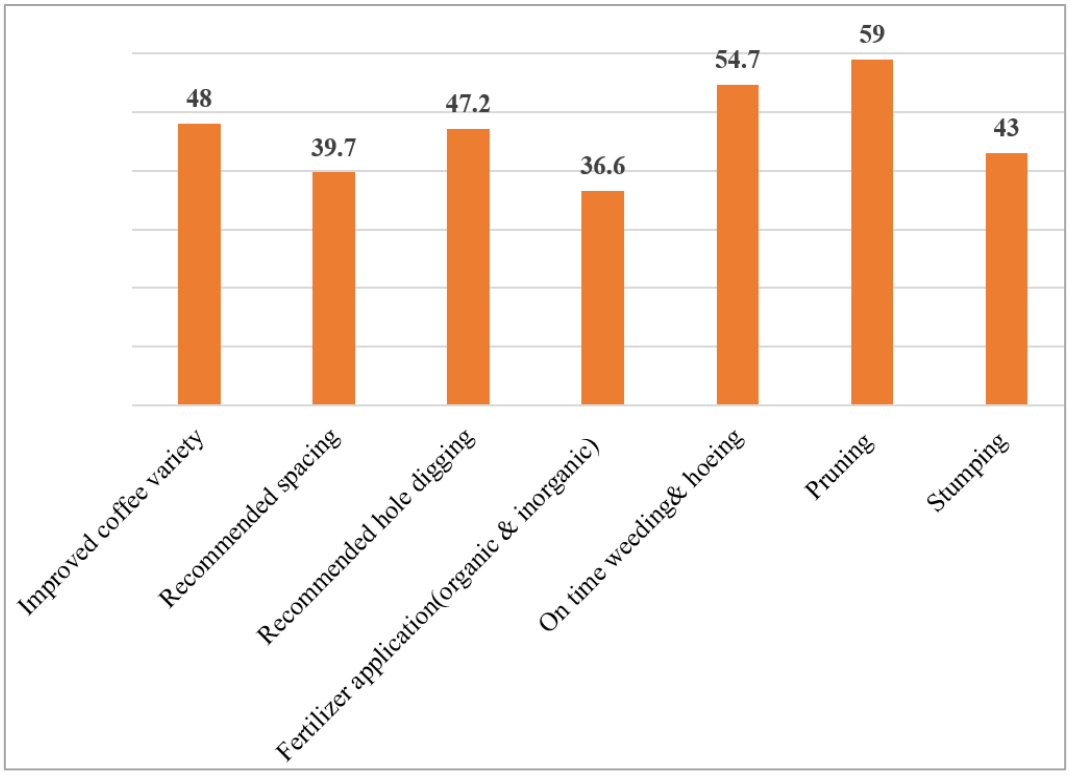
Source: Computed from survey data result, 2024

3.6. Improved Coffee Agronomic Technology Implementation in the Study Area

Improved agronomic practices like improved variety, recommended spacing, recommended hole digging, weeding, hoeing, pruning, stumping, fertilizer application were important technologies in coffee production. Household farmers responded that they were using improved technologies. From the respondent household farmers, 48% are using improved coffee variety. Stumping the old and unproductive coffee can renew the tree and help the tree to provide a better yield.

Coffee stump technology was important technology that needed to be used fully in order to alleviate the declining production due to the age of coffee trees (Mezigeb et al., 2019). From the respondent household farmers, 43% practice coffee stumping; the remaining farmers did not practice it. Pruning was the other important coffee production technology that increased aeration and reduced competition for nutrients. Additionally, pruning was to remove old or diseased branches for maintaining plant health and ensuring a good yield. This is done manually, often with the use of machetes or pruning scissors.

In this study, 59% of the respondents practice pruning, while 41% of them have not yet started to practice it. The households responded that the main reasons for not using the agronomic practices, such as pruning and stumping, were the lack of farm tools like scissors and hand saws that were mentioned. In the study area, 36.6% of the respondents use organic fertilizer like compost and manure for their coffee trees, and the remaining did not use any fertilizer (figure 3).



Source: Computed from survey data result, 2024

Figure 3. *Improved agronomic technology.*

3.7. Coffee Harvest and Postharvest Handling in the Study Area

The majority, 65.6% of household farmers, prioritize coffee quality by picking only ripe cherries. A significant portion, 34.4% of household farmers, still practiced strip harvesting due to cost, time, and labor constraints. This method may result in a mix of ripe, unripe, and overripe cherries, lowering

coffee quality. Most, 60.9% of households used raised beds, which coffee cherries are spread thinly on raised mesh beds or wooden structures to dry under the sun. A significant minority, 39.1% of households, still dry their coffee on the ground, where coffee cherries are spread on tarpaulins, mats, cemented ground, or bare ground to dry under sunlight. The most, 61.25% of household farmers, were used to common packaging methods, indicating that farmers relied on affordable and accessible materials like jute or polypropylene sacks. Nearly a third, 29.76% of farmers, were using hermetic bags, such as PICS bags. A small percentage, 8.99%, of farmers used traditional packaging, such as baskets, clay pots, or sacks made from local materials, due to limited access to modern materials.

The vast majority, 85.94% of farmers, stored coffee in their homes; household farmers used a separate room in their homes to store coffee, especially dried cherries or parchment coffee. A small number, 8.44% of farmers, used storage huts near their homes. Very few, 5.62%, farmers use separate houses with better protection against pests and moisture. The majority, 67.9% of farmers, store coffee for 1-3 months, possibly waiting for initial market prices to stabilize. Nearly a quarter, 23.3% of farmers, store coffee for longer periods, until price increases (Table 5).

Table 5. *Coffee Harvest and Postharvest handling.*

Variables		Occurrence	Percentage
Harvesting	Selecting red cherries	210	65.6
	Strip harvesting	110	34.4
Drying	On Ground	125	39.1
	On Raised Beds	195	60.9
Packaging	Traditional (clay pots, sacks)	29	8.99
	Jute Sack	196	61.25
	Hermetic bag	95	29.76
Storage	In Granaries	27	8.44
	In home Rooms	275	85.94
	Separate house	18	5.62
Storage time before sale	1-3 months	217	67.9
	>4 months	75	23.3
	Until price increase	28	8.8

Source: Computed from survey data result, 2024

3.7.1. Method of Coffee Processing and Forms of Coffee Sold to the Market in the Study Area

In the study area, coffee is sold in various forms depending on the stage of processing. The two forms, red cherry and dried coffee without dehulling (sun-dried cherry), were among the most common types sold by coffee farmers. Freshly picked, ripe coffee cherries are sold directly by farmers. Buyers were typically local coffee traders or cooperatives who process the cherries into washed coffee.

Whole cherries were dried under the sun without removing the pulp or mucilage. Dried cherries were sold to local traders or hulling stations, where the dried husk (pulp) is removed to extract beans. Coffee cherries are pulped (removing the outer fruit layer) but not yet hulled to remove the parchment layer. Common in areas with limited access to washing stations or during peak harvest when washing stations reach capacity.

The most common type sold indicated that drying is the predominant post-harvest method, possibly due to low cost and traditional practices. The majority, 42% of households, prefer sun-drying due to its low cost and traditional appeal. A significant portion, 31.2% of households, focuses on selling freshly harvested red cherries. Some, 19% of households, were diversifying their strategy by selling both forms (cherry and sun-dried coffee). A smaller group, 7.8% of households, were processing coffee to a semi-finished (honey process) state.

The majority, 68% of households, sell their coffee in village markets due to their proximity and accessibility, making them the most choice for daily transactions, especially for smallholder farmers. These are the primary hubs for coffee sales, likely due to their proximity to smallholder farmers,

making them accessible for daily transactions. Some, 21.9% of households sell at district markets, which offer access to a larger buyer base but involve more logistical challenges. Farmers also sell at district-level markets, which likely offer broader buyer access but require more logistical effort. A smaller proportion, 7.3% of households, access zonal markets, likely for formal transactions. Representing the smallest share, zonal markets may cater to more formal or larger-scale transactions. A few, 2.8% of household farmers, used a combination of district, zonal, and village markets aimed at maximizing opportunities.

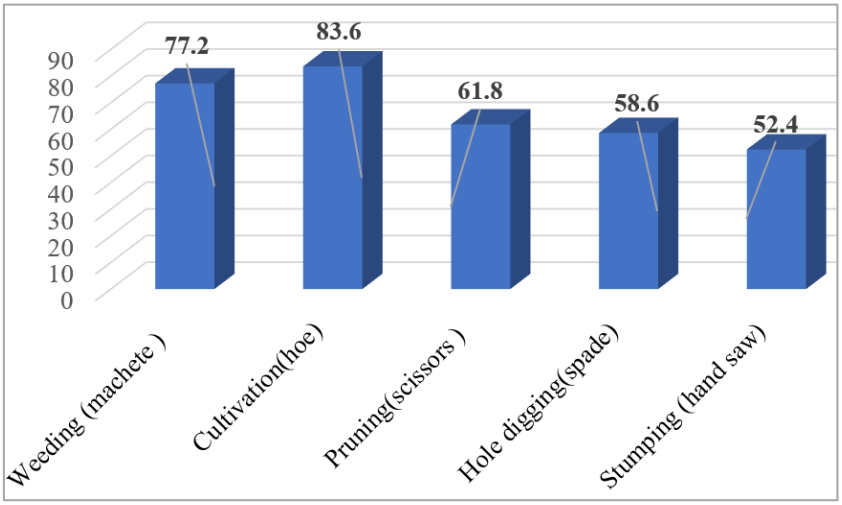
Nearly half, 47.6% of the households, rely on local traders for their coffee sales, indicating that most farmers rely on intermediaries for immediate cash returns and convenience. A significant portion, 38.8% of households, sells to cooperatives, reflecting their interest in better prices and access to larger-scale markets, although cooperatives may be geographically limited in the study area. A smaller group, 11.4% of households, sells to washing stations, which are specialized buyers focused on quality coffee. Specialized buyers focused on quality coffee for processing, indicating an emerging trend toward value addition. A small fraction, 2.6%, of household direct sales exporters, this suggests farmers have limited access to international markets, likely due to logistical and regulatory challenges (Table 6).

Table 6. *Market places, type of coffee sold and coffee buyers in the study Area.*

Market Places	Freq.	%	Forms of Coffee Sold	Freq.	%	Key Buyers	Freq.	%
District market	70	21.9	Sun-dried	134	42	Whole sellers	7	2.6
Village market	218	68	Red cheery	100	31.2	Local Traders	152	47.6
Zonal market	23	7.3	Red cheery and Sun-dried	61	19	Cooperative and Unions	124	38.8
District, zonal and village market	9	2.8	Semi-processed	25	7.8	Washing Stations	37	11.4

Source: Computed from survey data result, 2024

3.7.2. Types of Farm Tools Used in Coffee Production in the Study Area



Source: Computed from survey data result, 2024

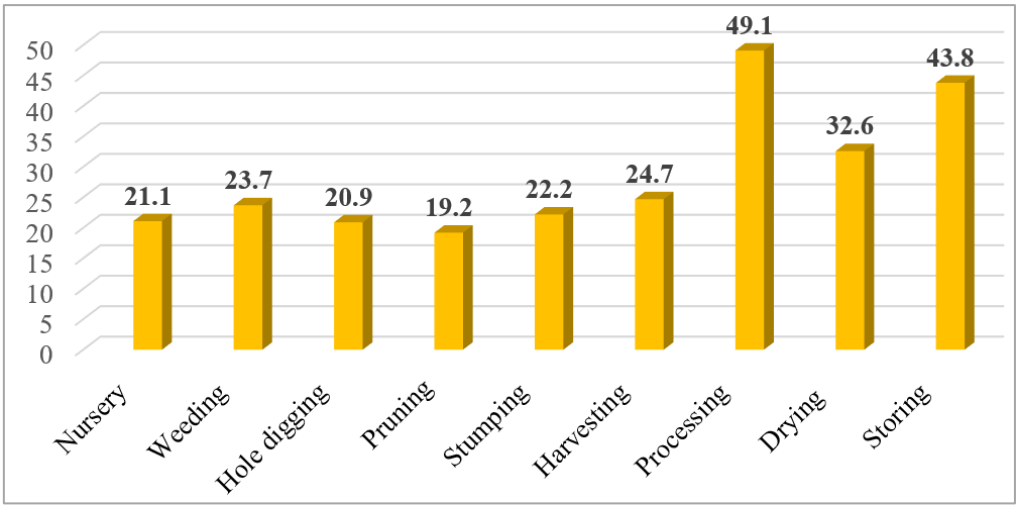
Figure 4. *Types of farm tools.*

Based on responses from 320 participants, (figure 4) presents the types of tools commonly used in coffee cultivation in the study area. The results reveal that hand tools like machetes and sickles were the most frequently used for weeding, with almost all respondents (77.2%) reporting their use. Hoes are the most commonly used tool for cultivation,

with 83.2% of respondents responding to their use. Scissors are the preferred tool for pruning, with 61.8% of respondents responding to their use. For hole digging, spades are the most commonly used tool, with 58.6% of respondents reporting their use. Finally, hand saws are the most commonly used tool for stumping, with 52.4% of respondents reporting their use. Understanding the types of tools used in coffee cultivation is essential for coffee farmers and researchers to identify areas where improvements can be made. By recognizing which tools are associated with higher levels of drudgery or injury, farmers and researchers can explore alternative tools or machines that can help reduce risks associated with the task.

3.7.3. Mechanization Technology Preference by the Coffee Producer Farmer Households in the Study Area

The figure showed that processing was the most preferred mechanization operation among 320 coffee producer households, followed by storing at 43.8%, drying at 32.6%, and harvesting at 24.7%, respectively. Based on the survey results, there were strong preferences for mechanization technology, indicating an interest in saving labor, time, and cost as well as in improving efficiency and quality control.



Source: Computed from survey data result, 2024

Figure 5. *Mechanization technology preference.*

3.7.4. Time, Cost and Labor Sensitive Works in Coffee Production in the Study Area

Coffee production in the study area, which is a major coffee-growing region, has unique challenges and opportunities related to time, cost, and labor-sensitive processes. In coffee production, achieving a balance between quality, efficiency, and profitability requires careful management of time, cost, and labor. Labor demand peaks during the harvest and processing seasons, leading to competition and increased costs. Poor road networks and limited access to mechanized equipment increase dependency on manual labor.

Harvesting (Rank 1, 73.3%), which was the most prioritized activity with a high percentage. This suggests that household farmers consider harvesting the most critical activity, likely due to the need for selective picking of coffee cherries. Weeding (Rank 2, 71.6%), it was indicated that farmers also place significant importance on keeping the coffee fields free from weeds. Hole digging (Rank 3, 45.6%), which was likely associated with planting new coffee trees, is moderately important. The percentage indicates that it was a necessary part of the cultivation process. Drying (rank 4, 36.4%), an essential post-harvest activity for coffee beans, whereas packaging and storage practices were relatively less costly activities, respectively (Table 7).

Table 7. *Time, cost and labor Sensitive works.*

Activities	Percentage	Ranks
Weeding	71.6	2
Harvesting	73.3	1
Drying	36.4	4
Hole digging	45.6	3
Packaging	18.1	5
Storing	9.7	6

Source: Computed from survey data result, 2024

3.8. Main Challenges and Opportunities of Coffee Production Technology in the Study Area

Survey results showed that challenges and opportunities in coffee production technology were ranked by their significance and provided the corresponding percentages (Table 8).

3.8.1. Challenges

Despite its strong position in coffee production, coffee farming in Southwestern Oromia faces several challenges. Lack of modern processing technology was ranked 1st among challenges, with 86.4% perceiving it as a significant issue. This suggests that modern processing facilities are critically lacking, which could hinder productivity and profitability in coffee production. Pest and disease were ranked 2nd, with 76.3% viewing it as a major challenge in coffee production. Coffee farms in the study area face threats from pests like the coffee berry borer and diseases like coffee leaf rust. This indicated an issue with pests and diseases affecting the crops. Lack of improved varieties was ranked 3rd, with 72.8% identifying it as a challenge. This points to a need for better coffee varieties to improve yields and resistance to diseases. Poor infrastructure was ranked 4th, with 54.3% seeing it as a problem. This suggested that issues like inadequate transportation and storage were also significant challenges in coffee production in the study area.

3.8.2. Opportunities

Despite the presence of challenges in coffee production, there were also opportunities in the study area. The presence of a good climate was ranked 1st among opportunities, with 86.7% of respondents responding that it was a major advantage. This indicates favorable weather conditions that support coffee production activities. Sufficient rainfall was ranked 2nd, with 75.32% of respondents seeing it as an advantage to produce coffee in the study area. This shows that natural water resources are available for farming, reducing dependence on artificial irrigation. Support from agricultural offices was ranked 3rd, with 53.77% of respondents considering it was an opportunity. This indicated that support from agricultural extension advisory services. Fertile soil was ranked 4th, with 49.54% of respondents seeing it as an opportunity. This suggested that there was the availability of fertile land but the need for better utilization.

Table 8. Challenges and opportunities.

Challenges	Ranks	Percent	Opportunities	Ranks	Percent
Poor infrastructure	4	54.3	Fertile soil	4	49.54
Lack of improved varieties	3	72.8	Good climate	1	86.7
Lack of Modern Processing	1	86.4	Sufficient rain fall	2	75.32
Pest and disease	2	76.3	Agri. Office support	3	53.77

Source: Computed from survey data result, 2024

4. Conclusion and Recommendations

4.1. Conclusion

Coffee farming in the southwestern region is predominantly smallholder-based and relies heavily on manual labor. A survey revealed that 76.9% of household income comes from coffee farming, while the remaining was generated from other sources. Among respondents, 59% practice pruning, while 41% do not, due to lack of tools such as scissors and hand saws as the main barrier. Most farmers (65.6%) prioritized quality by selectively picking ripe cherries; however, a significant portion, 34.4% of farmers, were still practicing strip harvesting due to time constraints. Coffee was typically stored at home, with 85.94% of households using a separate room. Coffee is sold primarily as red cherries or dried coffee, reflecting the prevalence of traditional, low-cost drying methods.

Village markets are the primary hubs for sales, preferred by 68% of farmers due to their proximity and accessibility. Buyers are usually local traders or cooperatives that process the coffee further. The survey indicated that there was strong interest in mechanization to save labor, reduce costs, and improve efficiency and quality control. Despite opportunities like favorable climate and rainfall, challenges such as inadequate infrastructure, disease, pest, and access to improved varieties hinder progress. Addressing these issues, particularly by introducing advanced pre- and post-harvest technologies, could significantly enhance the quality, efficiency, and sustainability of coffee production in the region.

To enhance sustainability and productivity of coffee production, addressing infrastructure gaps and introducing advanced pre- and post-harvest technologies such as mecha-

nized processing and pest management were critical. These measures could significantly boost quality and efficiency, benefiting smallholder coffee producers.

4.2. Recommendations

Based on the study findings, the following recommendations are recommended:

To enhance coffee production, it is essential to introduce disease-resistant and high-yielding coffee varieties developed by research institutions. Farmers training on sustainable farming, disease, pest, and advanced cultivation practices will improve productivity and quality of coffee. Mechanized pulping and drying technologies should be promoted to ensure efficient processing and consistent bean quality while reducing mold risks. Radio programs and mobile platforms can support farmers with real-time weather updates, market prices, and post-harvest best practices.

Given the high initial cost of mechanized technologies, government subsidies and accessible loan programs are vital to support smallholder farmers in adopting them. Additionally, comprehensive training and extension services are necessary to ensure farmers effectively utilize these new technologies, enabling sustainable and efficient coffee production. To boost coffee production and productivity, it is recommended to introduce mechanization to enhance productivity and reduce labor intensity, establish more coffee processing plants, and provide training on proper processing techniques. These measures aim to improve coffee quality, increase value, and enhance the livelihoods of coffee producer households.

Author Contributions

Lemma Gutema is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

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