

## Assessment of Coffee Farmers Mechanization Demand for Resource use Efficiency: Survey Result of Gomma District of Jimma Zone

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**Abstract:** The profitability of coffee farms depends largely on the availability and efficient use of farm resources. The study was aimed to assess coffee farmers' mechanization demands that minimize production and processing cost, time and energy. It was conducted in Gomma district of Jimma zone which is the most prominent coffee producing district in Ethiopia. The target population of the sample was coffee farmers having coffee land of greater than 2.5 hectares. The data was gathered from 65 sampled households using structured questionnaire. Descriptive statistics was the data analysis technique used. The study explored the use of simple hand tools in coffee farming operations. The majority of respondents own hand saw for stumping and pruning scissors for pruning. On other hands, only few farmers had wheel barrows and red cherry pulping machines. The result also pointed out that large number of farmers who pulp the cherry for seed uses hand pulping which is very traditional, time consuming and inefficient. The main reason behind this was lack of supply of manual pulping machines. The most expensive activity in coffee management as farmers responded was weeding. A farmer slashes his/her coffee farm 2-4 times a year. A single slashing cost ranges from 800-1600 ETB per hectare of land. Finally, farmers ranked their demand for coffee production and processing machines. Accordingly weeding, harvesting, drying, stumping and holing machines were ranked in ascending order. Thus, concerning bodies should emphasize on simple machine innovation and introduction according to the priority given above by the coffee farmers.

**Key words:** Mechanization • Profitability • Pruning • Pulping Machine • Stumping

### INTRODUCTION

Most of sub Saharan African countries are undernourished and food insecure. The main reason believed to cause this economic depression, poverty and starvation is the dependence of those countries on traditional agricultural systems. Studies on the region showed that 60% of farm power is provided by people's muscles and 25% is provided by drudge animals. The important features of those traditional agricultural systems is high energy consumption and limitation on the efficacy of essential farm operations thereby reducing crop yields [1, 2].

Agricultural mechanization is an essential agricultural input with the potential to transform rural families' livelihoods by facilitating increased output of higher value products while eliminating the drudgery associated with human muscle-powered agricultural production. It has direct and significant effect on land and labour

productivity, profitability and sustainability [3, 4]. Mechanization also plays a key role in enabling the growth of commercial agro food systems and increasing the efficiency of post-harvest handling, processing and marketing operations. Generally, increased accessibility of agricultural mechanization can contribute to Africa's agricultural and economic transformation [5].

The Ethiopian agricultural system is predominantly subsistence and characterized by the use of traditional farming implements and practices. Farmstead operations in crop production, animal husbandry and forestry operations are largely performed with bare hands or very rudimentary farm tools. The government has given due attention to agricultural sector as the overall economic growth in the country depends on the performance of this sector. A number of agricultural development strategies and plans have been formulated and implemented and almost all those strategies and plans focuses on enhancing technology generation and adoption of the

technologies to close the productivity and profitability gap in major crops. However, smallholder agricultural mechanization has not been provided emphasis as other yield improving inputs or technologies like improved seeds and fertilizers [6].

Mechanization in coffee production is a relatively new concept, but can be critical to successful and efficient production. The productivity and profitability of coffee farms depends largely on the availability and efficient use of farm facilities, factors of production and infrastructures. Nowadays coffee farmers' inclination to rely on coffee is declining because of two critical issues. The first issue is unfair coffee price farmers are incurring. This affects farmers' willingness to invest on coffee. The second is resource intensive behavior of coffee production and processing. The labour cost of coffee production activities such as land clearing, hoeing, weeding and harvesting is becoming higher and higher. Minimum wage rate paid for laborers by large private farms is higher than smallholder farmers. Those smallholder farmers cannot catch up the wage paid by large private farms. This causes coffee farmers to face labour scarcity especially during weeding and harvesting. Hence, coffee mechanization is the necessary condition for the sustainability of coffee production, processing and value addition.

**Objectives:** The main objective of the study was to assess coffee farmers' mechanization demands that minimizes the cost, time and energy and the specific objectives of the study are:

- To explore the most resource consuming coffee production activity among farmers' of the study area.
- To identify smallholder farmers' coffee production and processing machine which could save their scarce and expensive resources.
- To recommend concerning bodies (universities and poly techniques) the type of coffee production, processing and post-harvest machinery that should be introduced and adopted. Scope and Limitation of the Study: The study mainly emphasizes on assessment and identification of farmers' preference for different coffee production, post-harvest and processing machines. The survey's target group was farmers having coffee land size of more than 2.5 hectares. Due to budget constraint, the study was confined to one coffee potential district in Jimma zone and five peasant associations (PAs) randomly selected.

**Review of Literature:** Agricultural Mechanization: Agricultural mechanization involves the selection, operation, utilization and maintenance of mechanical devices and systems in agricultural operations and production for the utmost benefits of man [7]. The primary objective of agricultural mechanization is minimization of production costs, optimization of product quality and protection of workplace and environment.

Mechanization is a multi-dimensional concept and includes social, economic bases, technical and agricultural engineering, agricultural machinery engineering, programming and more importantly management [8]. It plays a key role in enabling the growth of commercial agro food systems and in increasing the efficiency of post-harvest handling, processing and marketing operations [5].

Agriculture mechanization has also many important implications for gender mainstreaming and gender relations. Women's role in agriculture is prevalent; they work in all aspects of farming operations like seed cleaning, sowing, planting, weeding, applying fertilizer/manure and pesticides, threshing and harvesting. Agriculture mechanization can help to reduce women's workload and facilitate difficult operations [9].

Mechanization faces different challenges in Africa. Affordability, availability, lack of farmers skills, lack of enabling laws to facilitate business start-ups and enterprise operations, complex fiscal systems, punitive import regulations and rigid labour laws are core bottle necks of mechanization in the continent [7].

Different social, economic and behavioral factors affect farmers' demand for mechanization. FAO, 2013 pointed out that low farmer income causes low saving which drives to low demand for mechanization. This low demand for agricultural machineries result low productivity and this vicious circle continue to cause low income (Fig. 1).

**Mechanization in Ethiopia:** Despite the long history of agriculture in Ethiopia and the start of using some sort of mechanization, still the country's agriculture is characterized by the use of traditional farming implements and practices with very low energy inputs. The entire field operations at small scale agriculture are performed with very simple farm tools with mainly human and animal power sources. Animal traction is the main farming technology of the smallholder farmers who dominate crop production in Ethiopia. Evidences repeatedly showed agriculture related mechanization and farm implement were not in place till the late 1950s where Jimma agricultural

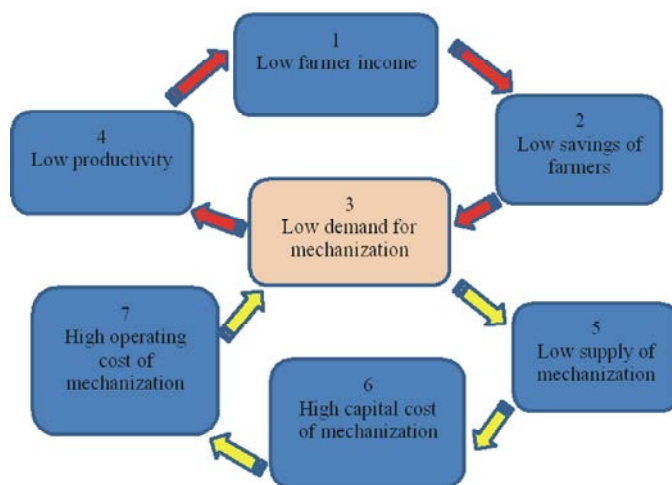


Fig. 1: Factors affecting the demand and supply of agricultural mechanization

Source: FAO, 2013

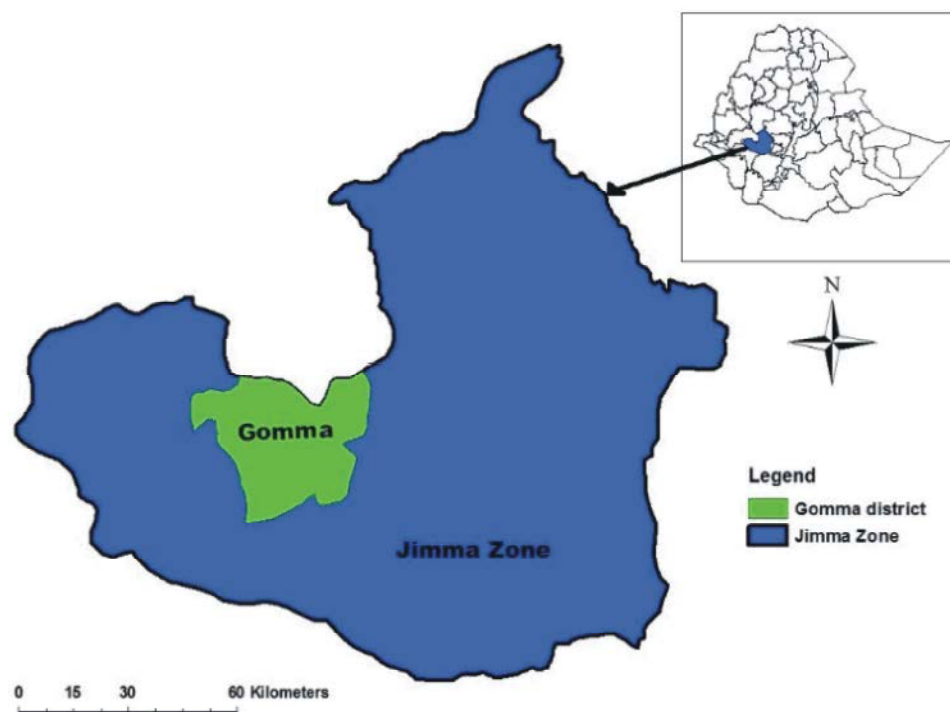


Fig. 2: Map of the study area

Table 1: Socio-economic characteristics of survey respondents

Variables	Minimum	Maximum	Mean	S.D
Family size	2.00	15.00	7.492	2.475
Coffee growing experience (years)	4.00	60.00	23.06	12.10
Total coffee land (ha)	2.61	40.00	5.188	7.198
Old coffee area (ha)	0.00	10.00	0.921	1.440
Productive coffee land (ha)	0.00	27.50	3.107	4.923
Young coffee area (ha)	0.00	16.00	1.271	2.324
Yield per hectare (kg)	600	23100	1385	475.7

Source: Own computation, 2018

technical school introduced mule-pulled plough for tillage practices. The introduction was followed by additional efforts made by Chilalo agricultural development unit (CADU) and Wolaita agricultural development unit (WADU) and ministry of agriculture in adapting these plough to these specific locations through the development units established at these specific locations [10]. In recognition to the need for agricultural mechanization development, the first higher learning level curriculum on agricultural mechanization program was started in 1958 at the Haramaya college of agriculture mechanization and art: the now Haramaya University. In 1990s, Awassa College of agriculture also opened the department of agricultural engineering and mechanization to train students at diploma and degree level. However, these learning institutes were criticized for focusing on large scale and capital intensive mechanization and ignoring the small holder farmers. In 1976, agricultural mechanization research unit was hosted at Melkasa agricultural research center to test different farm implements for tillage, planting, threshing and storage. Gradually, mechanization research continued getting better attention and the agricultural mechanization research directorate was established in 2000 at the Ethiopian institute of agricultural research (EIAR). Following the establishment of mechanization directorate at EIAR, Oromia, Amhara and Tigray Regional Agricultural Research Institutes also established a parallel structure to own mechanization research programs. Though limited in number, there are also private agricultural mechanization centers that contributed to the development of agricultural mechanization in Ethiopia. Selam vocational training center is a good example in this regard. Since 2002, there have been three principal development programs set by the Ethiopian government namely sustainable development and poverty reduction program (SDPRP), the plan for accelerated and sustained development to end poverty (PASDEP) and the growth and transformation plan (GTP I and II). In all the three programs, enhancing agricultural production and productivity through use of modern agricultural technologies is the fundamental direction. However, like improved seed and fertilizer use, agricultural mechanization and its development plan have not been given due attention in these programs. The existence of such a policy ad strategy gap could be a good indication for the slow expansion and development of agricultural mechanization in the country [6].

## **MATERIALS AND METHODS**

**Study Area Description:** The survey was conducted at Gomma district of Jimma zone which is the most prominent coffee producing district in Ethiopia. The district is located 397 km to southwest of capital Addis Ababa and 50 km away from Jimma town. The district extends between 7°40'-8°04' north latitudes and 36°17'-36°46' east longitudes. It is bordered with Gumay district in north, Limmu Kosa district in east, Manna district in southeast, Seka Chekorsa in south and Gera district in west. Currently the district is divided in to 36 PAs and five urban centers. Agaro town is the capital of the district. The annual rainfall of the district varies between 800-2000 mm. The agro climate of the district is high land 8% (highland), intermediate high land (88%) and low land (4%). The mean annual temperature ranges between 15 to 22°C (Gomma district coffee and tea development and marketing authority, 2018).

**Sampling Procedure:** The study followed multi stage sampling procedure to select sample households. In the first stage, one coffee potential district was identified in collaboration with Zone coffee experts and researchers from Jimma agricultural research center. Accordingly, Gomma district was selected deliberately. Secondly, five PAs were intentionally selected from the chosen district. Finally, 15 households from each PAs were randomly identified with district experts and development agents of the respective PAs.

**Target Population:** The target population of the sample was coffee farmers having coffee land of more than 2.5 hectares. Different studies witnessed that the demand and use of mechanization in agriculture increases as farm size increases since large farm size is relatively labor and capital intensive.

**Data Collection and Analysis:** Cross sectional data was collected to meet the objective of the study. The data was gathered from sampled households using structured questionnaire. Some socio economic backgrounds and coffee mechanization issues related to the households were collected through the interview. Secondary data was also collected from zonal and district bureaus of agriculture and natural resource development. The data collected was analyzed using descriptive statistics. Frequency, mean and descriptive statistics were commonly used methods for the analysis.

## RESULTS AND DISCUSSION

**Characteristics of Respondents:** The study covered five PAs of Gomma district namely Bashasha Badiya, Choche, Omo Funtule, Omo Gurude and Yachi Uracha. Fifteen households from each peasant association totally 65 coffee farmers were inter-vied. Out of the total inter-vied farmers, 96.9% were men and 3.1% were women headed households. It is known that women have resource constraint including land. That was the reason for the lessening of number of women household heads as the target population of the study was ownership of coffee land size greater than 2.5 hectares.

The descriptive result of the study revealed that the mean family size on the study area was 7.5 and the minimum coffee land of the respondents was 2.5 hectares and the maximum was 40 hectares. The average coffee land held by respondents was 5.188 hectares. Out of the respondents means coffee land, 0.921 was the average old coffee and 3.107 hectares and 1.271 hectares were the mean productive and young coffee respectively. The minimum dry (*Genfel*) coffee yield per hectare was 600 kilograms with a 2310 kilograms maximum and 1385 kilograms mean yield per hectare.

**Coffee Mechanization on the Area:** Respondents were asked whether they have some information regarding coffee production and processing related machines. About 69% of respondents have information about one of many coffee production, processing and post-harvest machines. More than 52% have information about red cherry coffee pulper and 34.5% have heard about roasted coffee grinder. On other hands, 7.5% and 5.7% have information about coffee roaster and weed cutter machines respectively (Fig. 3).

The study was also identified the source of information for the machines they heard about. The result showed that 42.1% of the coffee farmers have got the information about the machines from neighbor farmers. Concomitantly, 41.2% heard about the machines from bureau of agriculture and coffee and tea development and marketing authority. The rest 11.5, 3.1 and 2.1% got the information from NGOs, traders and farmers' cooperatives. The finding revealed that the source of information for the majority of coffee farmers was informal sources (Fig. 4).

The study also identified the use of simple hand tools in coffee farming operations. Machete, spade, shovel, axes, hoe and other rudimentary farm tools are common among the respondents in their daily farming

operations. Farmers' exposure for some advanced machines was also identified on the study. The survey result showed 64.6% of respondents own hand saw for stumping and 36.9% possess pruning scissors. On other hands, only 6.2% and 3.4% of respondents have wheel barrows and red cherry pulping machines respectively (Fig. 5).

Farmers used to harvest red cherry coffee for different purposes. They harvest to sell, dry and to prepare washed coffee and seed. About 96.6% farmers who pulp the cherry for seed uses hand pulping which is very traditional, time consuming and inefficient. The main reason behind this was lack of supply of manual pulping machines. Only 3.4% of respondents prepare seed using manual pulping machines. The source of the pulper was bureau of agriculture or coffee and tea development and marketing authority for 49.5% of respondents. Traders, NGOs and NGOs contribution is supplying the pulping machine was also significant (Fig. 6).

**Mechanization Demand on the Area:** Mechanization in coffee does not refer to driving a tractor or large machinery in a farm. It is, rather, finding the means to carry out the farm operations smoothly and effectively using minimum energy which is economic to the growers and improves the efficiency of the farm worker by reducing the difficulty. Use of mechanical technology of various power source, improved farm tools and equipment for timely completion of the various farm operations implies mechanization in coffee farms. Farmers' mechanization needs is identified below based on different farm activities/operations applied for coffee.

**Coffee Nursery:** The survey has identified the bottlenecks in coffee nursery establishment and management. Accordingly, 52.9% of respondents responded that lack of coffee polythene bag on the market was a problem. On other hands, inadequate water supply was constraint among 22.9% of respondents. Shortage of quality nursery equipment (tools) and wood and mulching grass scarcity was also problems raised by the respondents (Fig. 7).

**Coffee Hole Digging:** Farmers were asked whether they dig the recommended coffee planting hole 60cm\*60cm. About 51% of the respondents do not used to dig the recommended hole size and only 41% do. The reason they raised for this was the cost and labor intensive behavior of the job among 65% of respondents. The rest raised lack of awareness and lack of capital.

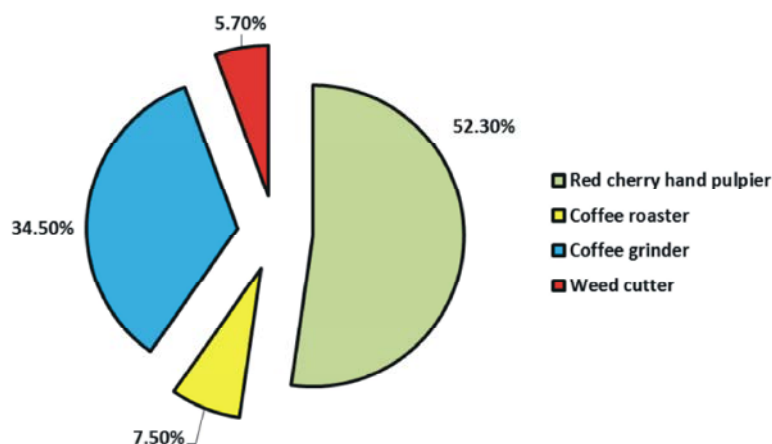


Fig. 3: Awareness of farmers for coffee related machines

Source: Own computation, 2018

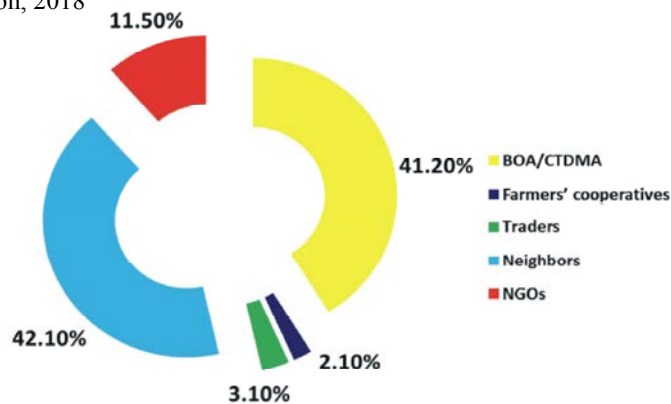


Fig. 4: Source of information for coffee related machines

Source: Own computation, 2018

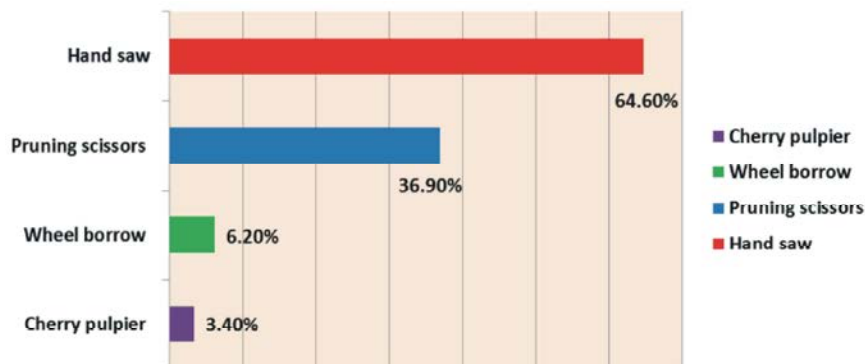


Fig. 5: Simple machines used by farmers

Source: Own computation, 2018

Table 2: Demand rank of coffee production and processing machines.

Machines	Rank	%
Weeding	1	73.8%
Harvesting	2	48.6%
Drying	3	46.6%
Stumping	4	41.3%
Holing	5	36.4%

Source: Own computation, 2018.

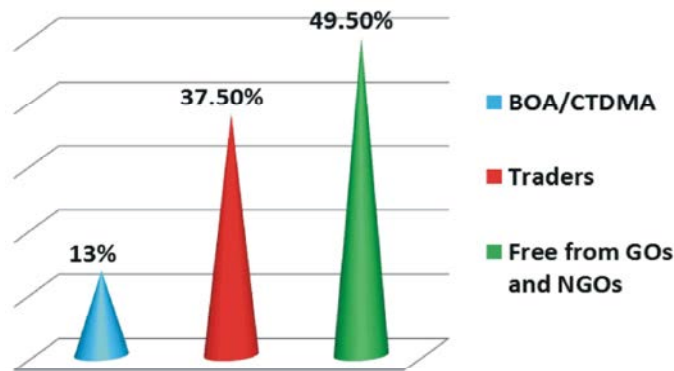


Fig. 6: Source of hand pulper for farmers  
Source: Own computation, 2018

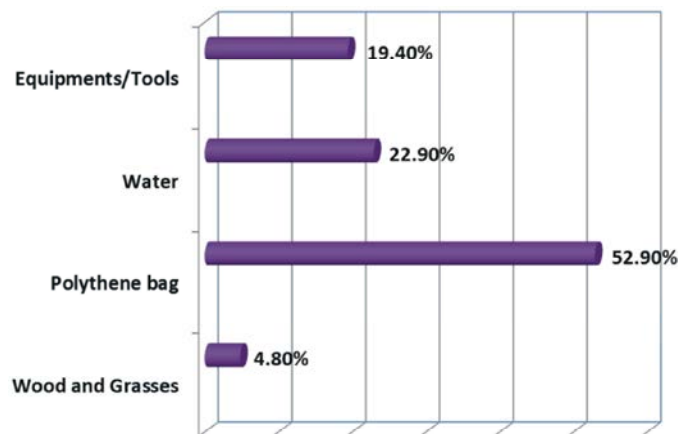


Fig. 7: Problems on coffee nursery establishment and management  
Source: Own computation, 2018.

A person digs 8-15 standardized coffee holes (60cm\*60cm) per day. The cost of a hole ranges from 1.5-3.50 ETB and the mean was 2.65 ETB. Finally, 95% of respondents need a holing machine and the rest 5% do not give the first priority to this machine.

**Coffee Weeding:** Weeding is the expensive activity in coffee management. Slashing is the weeding method for coffee. A coffee farmer slashes his coffee farm 2-4 times in a year based on the intensity of rainfall. The cost of slashing is different in different areas. A single slashing cost ranges from 800-1600 ETB per hectares of land. The activity is capital and labor intensive as it is frequently conducted in a year.

Farmers were asked whether they demands coffee weeding (slashing) machine and surprisingly all respondents said they need the technology. They are willing to pay a money ranges from 200-800 ETB for slashing a hectare of coffee land if weeding machine is available.

**Coffee Harvesting:** Coffee harvesting is a selective type of harvesting system. It is another labor and capital intensive activity in coffee production. Most of the time, farmers face scarcity of labor during harvesting. Farmers' coffee ripens at the same time with large private farm coffee. So, laborers prefer to be hired at private farms with relatively high wage as compared to what farmers pay them. Thus, farmers pay more for the laborers to cope up with the private farms' wage pay. This inflates the harvesting cost.

A person harvests 15-60 kg of red cherry coffee in a day (8 hours). The payment for a kilogram of red cherry coffee ranges from 1-3 ETB which is very costly. That is why about 98.5% of respondents like to have coffee harvesting machines.

**Coffee Pruning:** Pruning is a thinning process by which vigor is concentrated into certain parts of coffee Plant. Pruning is advantageous to maintain suitable crop to leaf ratio, prevent over bearing dieback and attain regular

uniform cropping yearly. It is very sensitive activity which needs knowledge and appropriate pruning material because of the problem of coffee wilt disease. About 25.9% of farmers prune their coffee. However, the equipment they used for pruning differs among the respondents. Accordingly, 54.2% uses pruning scissor and 25.3% uses saw to manage their coffee through pruning. However, 20.5% of respondents use their bare hand for pruning.

About 74.1% of respondents do not used to prune their coffee because of different reasons. Lack of knowledge was common problem among 84.6% of respondents. The rests raised the problems of the availability and poor quality of pruning scissors.

**Coffee Stumping:** After being exhausted due to various environmental factors or aging, a coffee tree needs to be rejuvenated. Stumping coffee trees in a slant position (45° angle) at 30-45 cm height above the ground renovate old coffee orchards and make them productive and manageable. Stumping also needs disinfection of farm implements such as hand saws for management of coffee wilt disease.

The result showed that 84.6% of respondents used to stump their old coffee. Hand saw and axes were stumping tools used among 80% and 20% of respondents who stumped their old coffee. Moreover, shortage and poor quality of stumping tools, animal trampling, dampening of stumped coffee and cost of stumping were problems raised by respondent.

**Uprooting Coffee:** When existing coffee farms become no more productive due to old age, uprooting and replanting is another method of rehabilitation of coffee trees. The survey result revealed that 49.2% of respondents have uprooted their old coffee and 50.8% were not since most coffee farmers prefer stumping over uprooting. Farmers were asked the bottlenecks they faced on uprooting. Availability and cost of labor was the problem identified on the activity among the respondents.

**Coffee Drying and Storing:** Coffee drying and storing method are of the most important activities which can contribute to the coffee quality significantly. The study has identified the most common coffee drying problems. Cost and availability of mesh wires and plastic sheet specifically used to cover the coffee and wood were important problems raised. Regarding coffee storing, only 3.6% owns coffee storage house. About 56.9% store their coffee at home in sisal sacks and the rest 39.5% store their

coffee at home in separate room. Some coffee storing problems were also raised by respondents. The survey result showed high cost and availability of sisal bags, cost of construction of storage house, rodents and termites were problems raised regarding coffee storage.

**Coffee Production and Processing Machines:** The choice of agricultural equipment is dictated by a multiplicity of factors including the nature and size of the farm, the profitability and access to finance, the economic status of the region, the accessibility to a range of equipment options at local level and the ownership of equipment. Farmers were asked to rank the most important machine of their demand in ascending order. More than 73% of respondents ranked weeding machine on the top and 48.6% demanded harvesting machine next to weeding. Drying, stumping and holing machines were also ranked 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> respectively (Table 2). The finding is consistent with the above result which witnessed that weeding was the most labor intensive of coffee farming operations. They opted the machine to save the cost and labor allocated for the operation. This implies the direct relation between operation cost and demand for machines.

## CONCLUSIONS AND RECOMMENDATIONS

**Conclusions:** Mechanization remains a neglected element of agricultural and rural development policies in Africa despite its benefits. The study was aimed to assess coffee farmers' mechanization demand that minimizes production and processing cost, time and energy.

The finding revealed that simple hand tools such as machete, spade, shovel, axes, hoe and other rudimentary farm tools in coffee farming operations is common. Farmers responded that weeding is the expensive activity in coffee management. It costs 800-1600 ETB per hectares of land. The activity is capital and labor intensive as it is frequently conducted (2-4 times in a year). Coffee harvesting is another labor and capital intensive activity in coffee production as the farmers responded. Farmers do not catch up what private large farms pay for harvesting which drives farmers to compete against those farmers. This inflates the cost of harvesting and reduces the net profit surely. On other hands, high cost and availability of sisal bags, cost of construction of storage house, rodents and termites was problems raised regarding coffee storage.

Farmers were asked to rank the most important machine of their demand in ascending order. The majority of respondents ranked weeding machine on the top and



demanding harvesting machine next to weeding. They opted the machine to save the cost and labor allocated for the operation.

**Recommendations and Way Forward:** Based on the above findings, the study recommended the following core issues:

- Concerning bodies such as universities and poly-technique colleges should emphasize on innovating simple coffee production, processing and post-harvest machineries according to the demand of farmers. In this regard, the entrepreneurial potential of agricultural engineers, young entrepreneurs, artisans and traders should be enhanced systematically.
- Introduction of medium or low level mechanization implements and technologies enables lighten burden of women who contribute most of the labor in coffee production, processing and post-harvest management.
- Output markets which generate the revenues that enable farmers to invest on machineries are the major driver for expansion of the machines. Thus, emphasis should be given to coffee marketing and price improvement.
- Farmers' lack of awareness system is not pushing the farmers to improve business skill and farming with new technology. Thus, extension workers should also consider the issue of agricultural mechanization to create demand for those agricultural technologies using different methods of information dissemination mechanisms.

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