



# An Integrated Approach to Solve Small Farm Holder's Mechanization Barriers in Ethiopia

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**Abstract.** Ethiopia has a long history of agricultural practices. But the deployment of agricultural mechanization is still minimal. Farm power is largely dependent on human muscle and oxen driven traditional farm techniques. Even though the effort and interest of agricultural mechanization grew from time to time yet it is not effective due to poor deployment strategy. The main objective of this study was to review and assess the effectiveness of the existing agro-machinery manufacturing, distribution and use in Amhara region of Ethiopia; identify the barriers of agro-machinery deployment actions and design an effective deployment model. The study carried out through collecting and analysis of secondary data related to past attempts followed by. Then primary data gathered and analyzed from the target audience using survey questionnaire, focused group discussion and interview. The study result reveals that poor agricultural mechanization in the region basically associated with inadequate infrastructure, lack of financing institute, fragmented lands, working culture and related ones. In addition there is no clear, adequate and comprehensive agricultural mechanization deployment model. The level of these problems were analyzed quantitatively. Then agricultural mechanization deployment model has been designed. The model offers particular responsibilities for each deployment tasks and protect overlap of responsibilities, remove task redundancy and trace out failure easily.

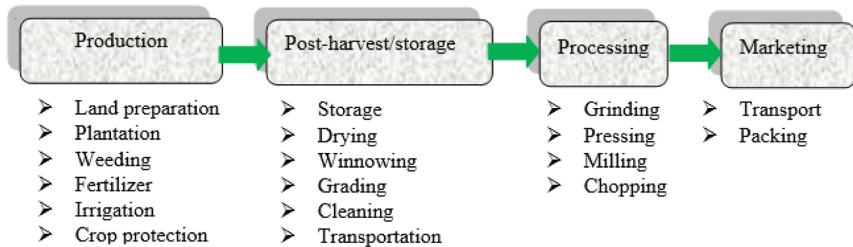
**Keywords:** Agricultural mechanization · Mechanization barriers · Mechanization deployment model

## 1 Introduction

The agricultural sector in Ethiopia provides employment to 85% of the population (of which women constitute 49.5% according to the 2007 census data), contributes 44% to the country's Gross domestic product (GDP) and 85% of the country's export earnings [1]. Agricultural mechanization implies the use of various power sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and

draught animals, enhance the cropping intensity, precision and timelines of efficiency of utilization of various crop inputs and reduce the losses at different stages of crop production. The end objective of farm mechanization is to enhance the overall productivity and production with the lowest cost of production. In many developing countries up to 80% of farm power is provided by human beings [2]. In most developed countries human beings are used less and less as a source of power and more for machine operation and control. The level, appropriate choice and subsequent proper use of mechanized inputs into agriculture has a direct and significant effect on achievable levels of land productivity, labor productivity, the profitability of farming, the environment and, last but not least, on the quality of life of people engaged in agriculture [3]. In developing countries human power and animal power used as farm power for small farm holder agricultural activities. In this countries it is extremely difficult to access mechanized farm tools [4].

Although there is a clear trend for animals to be replaced by engine power, this will take long time to achieve, even in rapidly developing countries such as India and China [5]. In some developing country animal power contribution declined practically from time to time. In these country the contribution of animal driven power is not more than 25% in small farm holders in today's agriculture activities. On the other hand similar to other sub-Saharan Africa countries, animal power and human muscles are still a central source of farm power in Ethiopia. Animal power contribute up to 25% and human power accounts 65% of farm power still now. As a result the contribution of mechanized tools is not beyond 10%. This hinder land and labor productivity in the region. Even though the African Union has proclaimed that the hand-hoe should be "consigned to the museum" by 2035, the current trend doesn't show significant improvements [7]. A study conducted in Kenya and Ethiopia revealed that, women usually contribute up to 80% of the labor needed for food preparation in sub-Saharan Africa [8].



**Fig. 1.** The potential contribution of mechanization in agriculture sector. (Source: Breuer et al. 2015)

Similar to indoor activities they are extremely engaged in farm activities starting from land preparation to postharvest activities [4]. This implies that unless mechanization implements address properly in the region it is difficult to reduce the work burden and improve the life of women. Agricultural machineries has a key role to improve labor productivities as shown in Fig. 1.

Inadequacy of farm power and machinery with the farmers continue as one of the major constraint for increasing agricultural productivity [9]. Ethiopian economy largely depend on agriculture. The overall economic growth in the country depends on the

performance of the sector. The government with development allies put great effort to improve the productivity of the sector. However, small farm holder agricultural mechanization hasn't got equal attention to other yield improving inputs like improved seeds and fertilizers [10]. In the past, ambitious politically motivated and fragmented mechanization schemes and misunderstood concepts and inappropriate selection and use of certain mechanization inputs have led to heavy financial losses, limit agricultural productivity and create negative interest on mechanization in the farming community rather than being a productive input [11]. Therefore, it is important to review and assess the current detached practice made by different stalk holders, identify and quantify the barriers then design an effective deployment model specific to the selected agro-climatic zone.

## **2 Research Methodology**

### **2.1 Research Approach**

Team of experts comprises of industrial engineering have experience in technology transfer, manufacturing engineering have experience in agro-mechanization and marketing management have experience on marketing strategy in collaboration with crop science and agriculture extension experts conducted the study. The study carried out through collecting and analysis of the necessary secondary data related to past attempts in transferring agro-equipments, followed by preliminary discussion with stock holders to guide and strength the primary data collection and analysis.

### **2.2 Research Design**

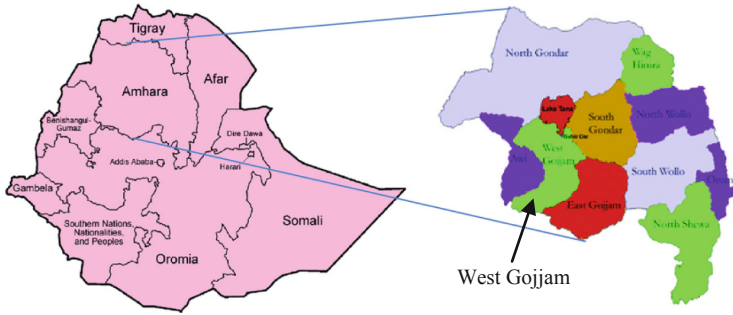
The purpose of this survey is to identifying potential entrepreneurs and promoting the technology of agricultural mechanization in Amhara Region. In the mean while this study followed a positivism paradigm with a survey type research design. A survey scheme provides a quantitative or numeric explanation of attitudes, trends or opinions of a population in the target area.

### **2.3 Target Population**

The purpose of this survey is focused at promoting mechanized agriculture in selected woredas. Therefore target population of this project were five potential woredas in Amhara region including selected by base line survey; Bahir Dar Zuria, Merawi, Dangila, Bure and Jabi-Tehnan as shown in Fig. 2.

### **2.4 Sampling Design and Sample Size Determination**

This research is a purposive research conducted to examine the level and barriers of mechanization practice in selected areas by base line study. As a result this study follow a purposive/judgmental sampling to determine the sample size of the research. Researchers prefer this sample design to include all potential stalk holders (enterprises, government's technology transfer offices, agriculture extension workers, farmer cooperatives and unions, non-governmental organizations (NGOs) and financial institutes) in the study areas as respondents.



**Fig. 2.** Study area (Ethiopia; Amhara region, west Gojjam)

## 2.5 Data Sources and Data Collection Instruments

The researchers gathered both secondary and primary data regarding agro-mechanization practice. Initially secondary data were gathered from current records of enterprises, government's technology transfer offices, agriculture extension workers, farmer cooperatives and unions, NGOs & financial institutes. These documents reviewed in office were mainly strategic plans, reports, manuals and regulations. Then primary data collected from stock holders, enterprises, technology transfer experts, agriculture extension workers, cooperative unions and financial institutes using survey questionnaire focused group discussion and interview. Researchers also conduct interview for the key informants from Amhara national regional state (ANRS) agriculture and technical and vocational education and training (TVET) bureau representatives, NGO representatives, enterprises owners, technology transfer experts, agriculture extension workers, cooperative unions and financial institute's representatives. Focused group discussions were conducted for managers and leaders of the union/entrepreneurs collect qualitative data.

## 2.6 Reliability and Validity Test

The study conducted a pilot study across five unions to pre-test the questionnaire prior to the main data collection exercise with a view to check for errors and test the tools for reliability. Cronbach alpha via SPSS software, which is a measure of internal consistency, used to test the internal reliability of the tools.

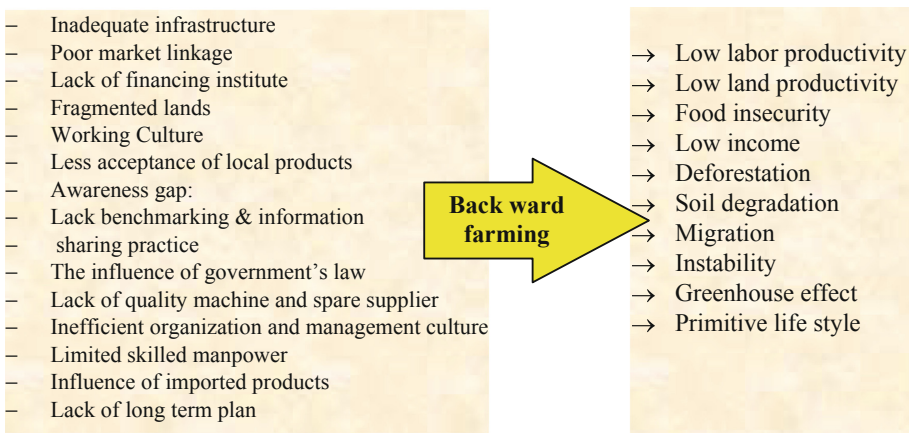
## 2.7 Data Analysis

In this study a mixed approach used. Both quantitative and qualitative data analysis techniques were employed. Linear regression analysis used to measure the relationship between the dependent variables (mechanization) and independent variables (mechanization barriers).

### 3 Result and Discussion

#### 3.1 Agro-Mechanization Barriers

In Ethiopia the “agricultural led industrialization development” framework encourages deployment of agriculture mechanization in large scale farms [12]. Even though it promises to invest in the sector and encourage development of improved farm implements and help to strengthen the production capacity of rural technology centers in implement manufacturing, still household agricultural mechanization is not properly addressed in policy documents. Small farm holder mechanization affected by different constraints. Identifying constraints and addressing policy issue is mandatory. In Ethiopia, most of the cultivated lands owned by small farm holders. As a result it is important to give proper attention for small farm holders than large scale mechanization.



**Fig. 3.** Root cause analysis of back ward farming practice in Ethiopia, west Gojjam

A survey was conducted to identify the basic constraints which hinder agriculture mechanization in the region. In this study all technical, economical social data relating mechanization influencing factors were studied by collecting data from manufacturer, facilitators and users as shown in Fig. 3. The survey result in Table 1 shows the basic factors influencing transfer farm equipment in stallholder farms (typically less than 2 ha). Some of the potential challenges are discussed below.

1. **Inadequate Infrastructure:** According to the survey result 72% of the respondent believe that infrastructure including electricity, road and water have significant impact on farm mechanization. The availability of infrastructure facilities and services as well as the efficiency of such services to a large extent determine the success of all other production endeavors. Investments in infrastructures such as energy, water, transportation and communication technologies promote economic growth and help to alleviate poverty and improve living conditions in the country [13]. Similar research’s shows that productivity increase in agriculture, which is an

**Table 1.** Analysis of agricultural mechanization barriers data collected from manufacturer, facilitators and users. (Source: survey on March 2018)

SN	Independent variable (mechanization barriers)	Percentage share					Influence 100%
		Strongly disagree	Disagree	Not decided	Agree	Strongly agree	
1	Inadequate infrastructure	0.00	1.23	6.67	24.00	68.10	<b>92.10</b>
2	Poor market linkage	0.00	2.57	6.33	23.50	67.60	<b>91.10</b>
3	Lack of financing institute	0.80	4.43	5.67	22.50	66.60	<b>89.10</b>
4	Fragmented lands	1.30	5.27	5.33	22.00	66.10	<b>88.10</b>
5	Working culture	1.80	6.10	5.00	21.50	65.60	<b>87.10</b>
6	Less acceptance of local products	2.80	7.77	4.33	20.50	64.60	<b>85.10</b>
7	Awareness gap on farm equipments	3.30	8.60	4.00	20.00	64.10	<b>84.10</b>
8	Lack benchmarking & information sharing practice	4.30	10.27	3.33	19.00	63.10	<b>82.10</b>
9	Influence of government's law, policy, rules & regulations	7.10	7.67	4.13	41.70	39.40	<b>81.10</b>
10	Lack of quality machinery and spare suppliers	7.10	7.67	4.13	41.70	39.40	<b>81.10</b>
11	Inefficient organization and management culture	7.60	7.33	4.97	41.20	38.90	<b>80.10</b>
12	Limited skilled manpower	8.10	7.00	5.80	40.70	38.40	<b>79.10</b>
13	Influence of imported products	8.60	6.67	6.63	40.20	37.90	<b>78.10</b>
14	Lack of long term plan	8.60	6.67	6.63	40.20	37.90	<b>78.10</b>

effective driver of economic growth and poverty reduction, depends on good rural infrastructure and access to appropriate technology [14].

2. **Poor Market Linkage:** Similar to other developing countries, the majority of the rural households engaged in smallholder agriculture characterized by low productivity, low information sharing mechanism, and limited market linkage. Many of these small farm holder farmers sold their product in the village markets where there is no potential consumers. Due to this most of them sold through intermediaries, due to the small scale of their production, the high transaction costs involved in reaching more distant markets, and their inability to comply with the stringent requirements relating to volume, quality, and timely delivery demanded by modern agricultural value chains. As a result the farmers are not properly from their products. They are benefiting intermediaries involved in the sector.

3. **Lack of Financing Institute:** Majority of the farmers are not capable to buy their own farm machinery. It is difficulty to possess their own machinery either individually or in group. On the other hand few rich farmers having own agricultural machines such as; maize thrasher, tractors and surface water pumps benefited from rental service in addition to their own agricultural productivity improvement. They use their machines in their own lands principally in the farming season and also operate them on hiring basis in others' lands after they complete their own farm activity and earn a substantial return. But, the number of such farmers is very limited. Till now there is no well-organized financing institutes in the community who can offer low interest farm machinery lease financing. Unless this issue addressed soon the problem well continue as it is.
4. **Fragmented Lands:** In Ethiopia, the average farm holding land size ranges from 0.25 ha–2 ha. In addition the total holding of land is not located in one place, rather, it is found in different places. This limits farm machines to perform at optimal efficiency. Even mini tractors, maize thrasher and surface water pumps face serious problems from frequent turnings in such fragmented lands. Even though there are few areas rental service offer in few farm machinery, it has been observed that many farmers cultivate their own land by traditional method.
5. **Working Culture:** Similar to farm machinery rental services barriers exist in other developing countries, there are various limiting factors in Ethiopia. Out of these inadequate infrastructure, poor market linkage, lack of financing institute, fragmented lands, low acceptance of local products, awareness gap, lack of quality machine and spare supplier are common ones [15]. But in the study area we have observed that there are cultural and spiritual norms which restrict the number of working days. They can't work consecutive days. One working day may be followed by a number of off-days. This reduce equipments utilization and increase depreciation cost. This makes the hire services infeasible in the region. Similar studies proved the existence of cultural barriers on using improved farm machineries and tools [16].
6. **Less Acceptance of Local Products:** Due to objective less deployment practice a lot of machinery have been produced and distributed to the community were not meet their objective. Proper attention was not given to farm mechanization until this day. Only a few manufacturers trying to fabricate simple manually operated and semi-automated farm machineries. To satisfy the ever growing population and subsequent food need, Ethiopia agriculture will have to improve its productivity through adopting modern mechanized implements. This includes promoting agricultural manufacturing workshops in the country.

Today, there are a lot of small and medium sized local metal workshops trying to manufacture agricultural machinery throughout the region as shown in Fig. 4. Many of them are manufacturing under standard machinery creating negative interest among the farmers. These small workshop owners, in general, do not have enough technical skill, use jigs and fixtures to produce any type of machineries. They get the prototype from the market and duplicate them without understanding their design and manufacturing requirements. While trying to copying these machines, they do not use exact quality materials and specifications as a result they are producing low quality machines. Due to this and similar factors locally produced machinery perceived as low quality and high in price [17].



**Fig. 4.** Sample maize thresher manufactured locally at higher cost than imported ones having low productivity and heavy to transport. (Source: survey result)

7. **Awareness Gap:** Similar to other developing countries in African small holder farmers have a huge traditional knowledge derived from experience over generations. But they have relatively limited access to new skill and knowledge. Farmers lack the knowledge and skills to select, operate and fix minor failures as a result misuse and mismanagement of farm machinery observed as a common challenge. Even though there is attempts through farmers trading center, it has been observed that the level of farmer training is relatively low and opportunities for further training are limited. In addition farmers trading center do not easily reach rural and remote communities. Since there is huge awareness gap on far tools the demand for related training is low. As a result it is not economical for private sectors. This enforce the government to take the burden to minimize awareness gap and work day and night. If not its influence agricultural productivity will continue [18].
8. **Lack Benchmarking & Information Sharing Practice:** Even though there are a lot of farmers training centers in the area built to for information and experience sharing goal they are not working effectively. As a result farmers restricted from benchmarking best method and technology.
9. **The Influence of Government's Law:** The whole stalk holders participating on farm machinery manufacturing, importing, distribution, retailing and rental services, faces organization and management constraints that prohibit its development. Most management constraints are common to private sector arise from Government's law, policy, rules and regulations. These includes lack of incentive mechanism, beurocratic licensing procedure, lack of enabling laws to facilitate business start-ups and enterprise operations, punitive import regulations. Private sector agricultural machinery manufacturing and distribution is at a premature stage in the country. It is vulnerable by international competition and imports, and held back by less developed distribution networks. Markets for mechanization rental services are also in their early stage.



- Lack of Quality Machine and Spare Supplier:** Farm equipments such as two wheel tractor, weedier, thresher and water pump introduced to the community by donors, government and private owner. Unfortunately, most of these equipments fail to produce the desired results as shown in Fig. 5. Even though there are a few factors attributed for these failure, lack of compatibility between equipments manufactured in donor countries and spare parts available in the market. Once the first breakdowns occur, the machines cannot be repaired and machinery garbage exist. Further, the high price of spare parts has discourage the imports to supply spare parts in the local market.



**Fig. 5.** Machinery “graveyards” due to quality inferiority and spare limitation. (Source: survey result)

- Inefficient Organization and Management Culture:** It refers to systemic application of scientific knowledge on planning, organizing, staffing and directing of resource to achieve the predefined goal of the firm. It is the core activity for any organization achievement. So proper organization structure staffed by the right professional and managed in the right way can achieve its objective with in short time and limited resource [19] (Fig. 6).



**Fig. 6.** Inefficient organization management and utilization practice. (Source: survey result)

12. **Limited Skilled Manpower:** The manufacturers, artisans, machine users and traders are mostly illiterate and don't have substantial knowledge and skill about machine selection, operation and maintenance. The manufacturers do not provide after sale technical service to the users. From the survey it has been found that machines are damped for minor and easily repairable faults. On the other hand in limited areas around towns mechanics provide repair and maintenance service at the expense of high charges. But in other cases, where mechanics are not readily available, they leave the machine without operation for long time till they get transportation. Most artisans responsible for technical support are rarely trained and lack adequate knowledge and skill about machines [20] (Fig. 7).



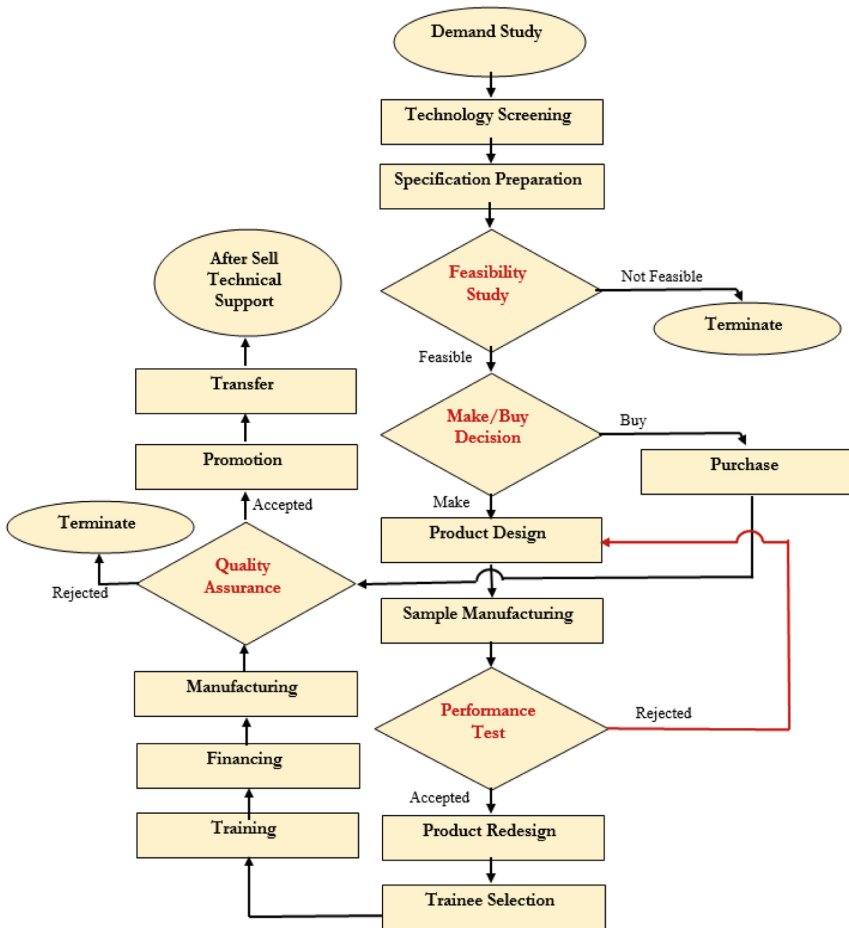
**Fig. 7.** Artisans trying to train themselves two wheel tractor operation (left) and tractors dismantled for spare part consumption to solve spare scarcity. (Source: survey result)

13. **Influence of Imported Products:** In Ethiopia, low cost imported farm machines and high cost of spare parts and materials have downcast the local manufacturers engaged in farm machinery production and distribution. In addition there is no strong quality control system on imported machinery. In Ethiopia similar to production machineries farm machineries are imported and distributed directly by the local importers to end users are low quality. This made the farmers unwilling to use them. Once these farmers decide not to use the machines, it becomes hard to convince them for a new machine.
14. **Lack of Long Term Plan:** The manufacturer and rental service providers focus on short term benefit. Agricultural mechanization takes place in a specific process with continual improvement. The process needs a long term goal that can be achieved through long term, well organized missions. Unless long-term establishment made it is difficult to penetrate the current technical, economical, political and social barriers in the sector. Therefore, provision of demand driven support to operational systems and processes, facilitating innovative solutions for institutional capacity development, long base establishment needed.

### 3.2 Agro-Mechanization Deployment Model

In Ethiopia, there was no clear, adequate and comprehensive agricultural mechanization deployment model that can alleviate the upper mentioned barriers. The country

mechanization strategy is in compass different agricultural mechanization alternatives for different farm sizes. The document focuses on value chain’s perspective starting from machinery design to distribution for end users. But it lacks integration of activities and stalk holders. In addition the strategy doesn’t offer particular responsibilities for each deployment tasks. The country’s strategy needs specific deployment model for each agro-ecological zone. The need of designing and implementing agricultural mechanization deployment model for effective and efficient strategy is mandatory. For the purpose of developing agribusinesses contributing to poverty reduction, and increasing farm income through production, processing, and sales, a comprehensive model has been developed for effective deployment of agricultural machinery, through introduction of agricultural machinery mainly driven by motive power. Based on the study results following business model is developed as shown in Fig. 8 below:



**Fig. 8.** Agricultural mechanization deployment model for small farm holders based on the survey result.

### 3.3 Process Description

The use of quality farm equipments at lowest possible cost is a request for Ethiopia agriculture productivity improvement. Similarly development of competitive Agricultural or farm equipment is a prerequisite for any micro- enterprise involved on farm equipment production success. Product development does not certainly mean discovering revolutionary new inventions, nor does it just involve retrieving on an old solutions. A successful product development strategy commonly results from structural thinking along with new approach, free from old approaches and none scientific designs procedure and materials selection. The designed deployment model categorized in to 18 distinct tasks having a particular responsibility and approaches as presented herein:

1. **Demand Study:** Out of all the steps in product deployment process, definition of need is the most important step. A complete and systematic understanding of the need is a fundamental requirement in achieving the desired solution. The final goal of product deployment is how well it sells or accepted by the customer (Farmers/Unions/Government). This can be achieved through well understanding of customer's requirement and providing what a customer wants in the product. This implies well defining the product requirements precisely before any design or manufacturing task carried out is far the most important task. It is important to understand customers drive the development of a better products. It is thus important to gather the need of farmers when starting farm equipment design. The needs of the farmers can be gathered either of any surveying techniques; either using interview, conducting focus group discussion, conducting customer survey and collecting customer complaints. Then customer requirements must be characterized on the basis of performance, time, cost and quality.
2. **Technology Screening:** It is the process of selecting the best machinery from available alternatives using technical, economic, social factors. Every technology wants a formal and organized evaluation process that must suitable with facility and labor skills, contribution margin, size of market, break-even analysis and return on sales. Machinery screening criteria should include at least product quality, product cost, safety level, size (weight and dimension), mode of operation (manual or automatic), energy source (electric/fuel/solar), running cost, manufacturability by local material, machine and man power, ease of operation and maintenance, availability of spare and simplicity of transportation.
3. **Specification Preparation:** Specification preparation reference to preparing a comprehensive picture of the product requirements. The specification should have to include the capacity of the machine, reliability, skilled man power required for operation and maintenance, power in put, mode of operation is either manual or automatic, transportation mechanism, and related technical terms. Basically the productivity and safe operation of any farm machinery and equipments depends on specification preparation before design or purchase. The equipment specification should be predefined before any financial analysis made for selection. The product specification is important to control the quality of the product deployment exercise. It should define all design and manufacturing process of any specific part or

product. The quality function deployment tool provides the most crucial inputs in writing the product design/purchase specifications.

4. **Feasibility Study:** Agricultural mechanization practice should be technically capable, economically feasible, environmentally friendly and socially acceptable. A feasibility study should be conducted to examine the feasibility of a proposed equipment. It is used to determine the proposed farm machines are viable. A complete feasibility study states whether the product is worth investment or not. A well-designed study should be free of political motivation and special group interest. But it should offer a historical background of the business/service provision, such as a description of the product capacity and capabilities, financial statements, marketing researches, details of operations and management tasks, policy issues, legal requirements and tax obligations. Then after feasibility assessment technical implementation and project operation modality will come up. Agro-machinery deployment project feasibility study needs detail investigation of technical, economic, legal, operational and scheduling feasibility.
5. **Manufacture or Buy Decision:** Any production businesses always have to consider low cost alternatives on a daily business activities. One of these decisions is whether the component/product shall be manufactured inside or Buy/outsourcing decision. It is the action of deciding between manufacturing an item internally (or in-house) or buying it from an external supplier (also known as outsourcing). Some companies perform all activities starting from manufacturing of raw materials to the final distribution of the product and delivery of after sales technical services. Contrary other companies may be interested on buying a lot of the parts and materials that are required for their finished products assembly. The second alternative is considered when it causes better quality and lower expenses than would be possible if the business were to attempt to manufacture the whole/parts of the product or provide a service by itself. On the other hand it is important to take control over those outsourced services or parts/products for maintaining its competitive position. To come up for a good make or buy decision, it is indispensable to thoroughly examine all of the expenses associated with product manufacturing and costs associated with buying the goods/service. Generally the evaluation process has to consider strategic impact, expertise, quality considerations, available capacity and speed of production and cost components.
6. **Purchasing:** The purchase process shall be done according to Amhara regional state purchasing regulation.
7. **Product Design:** It is the process of determining the product's characteristics including its appearance, dimensions, tolerances, materials and performance standards. Product design must support product manufacturability (the ease with which a product can be made). Product design task is a continuity of specification preparation. The design work should solve potential problems, reduce costs & shorten time to market. All the design work starting from conceptual design to the final embodiment design and detail design needs due attention and is done by the right professionals.
8. **Sample Manufacturing:** Based on the design document single product will be manufactured. The manufacturing process should be as per the designed process plan and consistent to the actual manufacturing equipments. In past practice we have

observed that the sample products manufactured in highly automated industries like Ethiopian metal and engineering corporation (METEC) at higher precision. But the products produced at small enterprises having less experience, medium skill and simple hand tools. As a result there is great deviation between actual products and sample ones.

9. **Performance Test:** The development of a new customized technology at early stage commonly the evolution is limited by the lack of ideas. A single good idea can solve several constraints and foster the products development exponentially. Gradually the growth becomes linear when the fundamental ideas are in place and the progress is focused on filling the minor gaps between the fundamental ideas. During this phase the marketing task will come to stage. But through time the product technological competency will begins to decline and improvements come with greater difficulty. Finally matured products improved slowly and approaches to its death. The success of a technology based company lies on its research & development (R&D) program, transfer to another technology growth curve offers greater possibilities. In addition to conformance of the product to the designed purpose product performance test criteria might include reliability, throughput time, process velocity, productivity improvement, utilization of capacity and efficiency.
10. **Product Redesign:** Based on performance test the geometric dimension, feature, material and other design parameters of the machine should be modified. Revised calculations are carried out for better operating capacity, improved safety, optimizing cross sections and resultant stress, considering the effect of stress concentration. When this values differ from desired values, the dimensions of the component are modified. The process will continued up to the desired values of operating capacity, better factor of safety and stress at grave cross section are obtained. The modification may include optimization of product size and shape, material type and production process.
11. **Trainee Selection:** The other most important issue is trainee selection. In past practice it is observed that the selection process is unfair and corrupted. As a result of this it is not possible to create a significant amount of enterprises in the area nevertheless of the huge effort made. The selection criteria should be objective oriented and must be made based on real interest, working culture and ethics, professional back ground, financial capability and existing practice in similar activities.
12. **Training:** Specific theoretical and practical training should be given for both manufacturer, operator and maintenance experts. Manufacturer trainings are should be designed for new or experienced manufacturers. The training has to insure the selected manufacturers can manufacture the product at predefined quality and productivity level. Similarly proper training should be given for operators and maintenance craft. The training should be able to operate the machine at optimal performance; imperative to know and understand the machine they are going to operating in order to ensure safety and minimize accident or injury risk on the job site; be able protecting the investment and the durability of the machine and optimizing utilization of the machine.
13. **Financing:** Even though pilot-scale farm equipments have been developed with better performance characteristics, use of such equipments remains limited due

financial limitations. Currently Amhara credit and saving institute (ACSI), Walya capital financing and Development bank of Ethiopia has started lease financing for micro and medium manufacturing industries. But it is a short term financing and doesn't include operational costs adequately. Manufacturers perceive high risks in financing farm equipment, primarily due to technological uncertainties and low affluence of users. In the absence of appropriate micro-financing arrangements, manufacturers are often unwilling to be involved in the sector. So there must be special financial arrangement to deploy farm equipments. This includes integration of donor, long term low interest loan for both manufacturers and users, subsidizer farm equipment supply and subsidizer farm equipment rental service.

14. **Manufacturing:** Manufacturing, which is an extremely important issue. Some of the problem in manufacturing process are fabrication without design, scarcity of skilled man power, materials and production machinery. The production of farm equipments involve various manufacturing processes such as casting and molding, machining, joining, and shearing and forming. But some components must be purchased or out sourced to other manufacturers.
15. **Quality Assurance:** The quality of most farm machinery manufactured by small scale industries in the country observed they are not meet the required service. Farmers are suffering from non-standard low quality products. The machines encountered longer down time, low output and high operational cost. The quality of equipment has to be improved. So it is important to inspections at various stages till they are finally assembled & packed as per their quality standards through well designed quality assurance procedures.
16. **Promotion:** Technological product passes through a cyclic process starting from birth, followed by an initial growth phase, then a relatively stable matured phase and finally into a decreasing phase that eventually ends in the death of the product. In early phase the product is new to the market and the customer acceptance is minimum and its market share is minimum. As a result the product needs to promote effectively. In this regard using sample product demonstrating its benefit practically in site required. Mouth promotion will not work longer. The farmers has lost their trust by old practices. So it is important to allocate enough budget and demonstrate the products productivity, ease of operation and maintenance, consistent with their culture and working habits is mandatory. But during the growth phase information of the product and its acceptance reaches to a wider customers. Needs less promotional effort. Rather it is better to focus on technical and managerial support. Through the maturity phase the product is broadly acceptable and market share are now stable, and it grows as parallel to the growing rate of the sector economy. Needs only strong technical support. This includes on job training, maintenance service, supply of spare etc.
17. **Transfer (sell/rent):** To transfer the product to the community there is two alternatives, sell or rental. To sell the product for the community the product has to be affordable and needy for individual applications. Such products have low capacity and small in size. This includes manual tools, semi mechanized equipments and to some extent small capacity mechanized equipments. Contrary devices having large capacity and high initial cost shall be considered for rental. This devices include fully mechanized devices such as high capacity tractor, combiner and thrashers.

So before any promotion activity performed the technical team has to decide the way of transfer. Farmers' cooperatives and unions and private business sectors has to promote, financially and technically support to invest on farm machinery rentals. In this regard the government structure (bureau of Agriculture) and NGOs involved in the sector has to do more.

18. **After Sell Technical Support:** After sales technical and managerial support after distribution of farm machinery is another hot concern in Ethiopia. There is huge knowledge and skill gap among the majority of farmers. Even though there are farmer training centers among the community they are not operational and provide the required service. There must be well organized regular on job operation and maintenance training before hand over and on job practice. In addition to training it is important to create product and spare supply channels. This is a particularly important issue. In this regard Ethiopian agricultural transformation agency (ATA) with Bahir Dar Institute of Technology (BiT) has started to create qualified technical entrepreneurs who can give maintenance service, rental service, supply spares. This effort should be strengthened. One of the factors that can ensure availability of agricultural equipments is an effective and efficient maintenance engineering system. Gone were the days when maintenance was not given adequate attention. For any farm machinery, more attention is now given to maintenance function. Therefore, considering the need for maintenance with technological advancement in production facilities, technical and vocational colleges, universities, manufacturers and suppliers have the responsibility for knowledge transfer. Similarly effectiveness of preventive maintenance rely on availability of quality spare at reasonable price. Any responsible governmental agencies, manufacturer and suppliers. Users have to provide important selection criteria before purchase. Spare parts requirement and its purchase must be planned and managed systematic way by the right professional.

## 4 Conclusion and Recommendation

The need for agricultural mechanization in Amhara Region of Ethiopia has become more acute in recent years due to rapid population growth and high labor wage. The production and productivity in Ethiopia agriculture cannot be enhanced by primitive and traditional practices of farming. There is a strong need for farm machinery rental service among small farm holders. Similarity quality manufacturing and after sales support provision for farm machinery are also needed to assure reliability of farm machinery deployment. The survey results outlined the most important factors inhibiting introduction of mechanization on small-scale farms in the region. To alleviate these challenges an agricultural mechanization deployment model has been designed. The model will create clear Responsibility, integration between activities and stalk holders to foster manufacturing, distribution and utilization of farm equipments. So the government has to take the lead to bring the fragmented mechanization practice performed by manufacturers, TVET colleges, unions/farmers, GOs, NGOs by implement the model.

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