



**FARM MECHANIZATION AND CONSERVATION
AGRICULTURE FOR SUSTAINABLE INTENSIFICATION
(FACASI) PROJECT**

**MARKET ANALYSIS FOR SMALL MECHANIZATION-
ETHIOPIA**

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List of Acronyms

AETS	Agricultural Equipment and Technical Services
ATA	Agricultural Transformation Agency
ATVET	Agricultural, Technical, Vocational and Educational Training
BBM	Broad Bed Maker
CSA	Central Statistical Agency
CIMMYT	International Maize and Wheat Improvement Center
DAs	Development Agents
EIAR	Ethiopian Institute of Agricultural Research
ETB	Ethiopian Transaction Birr
GDP	Gross Domestic Product
GOE	Government of Ethiopia
GTP	Growth and Transformation Plan
FAO	Food and Agricultural Organization of United Nations
FHHs	Female Headed Households
FTCs	Farmer Training Centers
IFPRI	International Food Policy and Research Institute
JV	Joint Venture
METEC	Metals and Engineering Corporations
MFI s	Microfinance Institutions
MOA	Ministry of Agriculture
SME	Small and medium Enterprise
NARS	National Agricultural Research System
NGO	Non-Governmental Organization
BOA	Bureau of Agriculture
SACCO	Saving and Credit Cooperatives
2 WTs	Two Wheeled Tractors

Executive summary

The Ethiopian agricultural system is predominantly subsistence, characterized by the use of traditional farming implements and practices. Agriculture, which employs 85% of the population, continues to use hand-tools and tillage equipment from thousands of years ago. These implements are hand tools or operated using animal power, which is mainly oxen. Similarly farmstead operations in crop production, animal husbandry and forestry operations are by and large performed with bare hands or very rudimentary farm tools.

Mechanization, along with other farm inputs such as fertilizers, improved seeds and pesticides, can significantly improve agricultural productivity in Ethiopia. Mechanization is a powerful tool in achieving sustainable agricultural production because it enhances human capacity with the potential beneficiaries being men and women farmers. It increases timeliness, efficiency and consistency in field operations. This is critical for land preparation especially in Ethiopia where there is sequential cropping owing to the receipt of rainfall through two seasons a year in substantial parts of the country.

Farm mechanization can help perform the power-intensive and ergonomically arduous tasks. It can also relieve the growing seasonal labor constraints that are experienced by farmers in several parts of the country. It also helps compensate for the immigration of rural youth who are disenchanted with the drudgery involved in agriculture. Thus mechanization, contrary to the restricted view on labor displacement, stands to compliment human labor in improving agriculture production in Ethiopia.

Four wheel and two wheel tractors can facilitate other off-the-farm tasks such as transportation, driving pumps and agro-processing equipment, maintenance of farm, and rural infrastructure. The requirements of farm power (mostly in the forms of power tiller, tractor and draught animals) shall be initially made available in the country by the government and private sectors. After the initial wave of investments, the government shall gradually withdraw and hand over to the private sector. The government shall nevertheless continue to remain as a catalyst in sustaining mechanization in the country.

Meanwhile, creating credit access to farmers who otherwise would adopt mechanization options is critical in providing the transformation. Here it will be important to help farmers' co-operatives leverage their collective bargaining power by assisting in establishing business plan, financial integrity and wherever applicable guarantee loans. Farmers and potential entrepreneurs need to be aware that besides the profitability in using and providing (hire) mechanization services in the farm, machineries such as tractor and power tillers can also be used in generating additional revenues through off-farm activities such as transport and infrastructure development.

Building a strong private sector on farm mechanization will create demand and sustenance of the supply of farm power, implements and spare parts.

Technical skills need to be developed at grass-root levels involving rural artisans, operators, mechanic, service providers, farmers and other end-users. Development of agriculture engineering sector in the country will enable creation of new designs of ergonomic tools for human labor and draught animals, and further widen the choice of mechanization options for local conditions.

Mechanization options that help conserve natural resources such as land, soil fertility and water need to be developed and endorsed. Ethiopia needs a massive adoption program on mechanization delivering knowledge and awareness amongst farmers through potential entrepreneurs and extension agents. Introduction of mechanization at various stages of farm operations will not only improve the agricultural commodity chains but also enhance rural employment opportunities and profitability of farming.

Chapter one: Introduction

Introduction

1.1. Background

Agriculture in Ethiopia is characterized by small holdings, due to high population density with nearly two-third of the population residing in rural areas. There are 111.5 million hectares of land in Ethiopia, 74.5 million hectares of which is suitable for agriculture, and 13.6 million hectares of which is currently under production. Farmers produce cereal crops (wheat, barley, maize, and rice), oil seeds (sesame, Niger seeds, canola, linseed, ground nuts and sunflower, lentils), pulses (soya beans, haricot beans, chickpeas, beans and lentils), beverage crops (coffee and tea), cotton, horticulture and apiculture.

Large scale commercial agriculture has expanded partly due to foreign direct investment. The Ethiopian government is seeking private sector investors to help modernize the agricultural sector and help it produce more efficiently, particularly with large-scale commercial farming and agro industrial activities. Ethiopia has created a more attractive investment climate in recent years by providing potential investors with various tax breaks, access to affordable land, and a relatively efficient investment process.

The government plans to spend about USD 4.4 billion in agriculture during the GTP period 2010/11- 2014/15. Initiatives will be undertaken such as the importation and adaptation of existing and proven technologies, including agricultural mechanization, research on crop, livestock and natural resources. The agricultural sector suffers from poor cultivation practices, overgrazing, deforestation, underdeveloped water resources and drought. According to the Ministry of Agriculture, Ethiopia is estimated as having one of the highest rates of soil nutrient depletion in Sub-Saharan Africa.

Agricultural Mechanization is an important link in achievement of effective growth in production and it needs to be addressed in larger context. Despite the big potential of agriculture in Ethiopia, the low level of engineering technology input in agriculture has been one of the main constraints hindering the modernization of the country's agriculture and food production systems. One of the major causes for the disappointing performance and low contribution of agricultural mechanization to agricultural development has been the fragmented approach to mechanization issues (Bishop and Morris 1992; Mrema and Odigboh, 1993). This often arises from poor (or no) planning and over-reliance on unpredictable or unsuitable aid-in-kind for many mechanization inputs, as well as limited co-ordination within and between government and private sector agencies dealing with mechanization. Thus, developing appropriate mechanization technology will improve production and productivity, reduce the huge production losses and it has a great contribution to food security. Moreover it is only when the environment is made conducive through proper use of appropriate energy and improved implements, will there be an

improvement in the working conditions and performance of jobs that would otherwise be difficult to accomplish in the traditional way.

1.2. Objectives

- Analyze the agricultural mechanization market system, particularly:
 - a) Underlying systematic constraints and opportunities
 - b) Key market actors
 - c) Key areas that needed to be strengthened or established; and
 - d) Enabling environment and
- Identify options and entry points for interventions

1.3. Methodology

Research tools

- **Literature review:** Sub-sector studies on agricultural mechanization in Ethiopia are largely unavailable. Hence, quantitative information on various numbers of machinery collected from limited secondary data was triangulated with the information from importers, dealers and manufacturers.
- **Interviews:** checklist was designed and used to interview the various actors that cover all the component of the subsector. One to one and key informant interviews, (focus group discussion) were used to understand and learn about the sector in line with the overall objective of the study.
- **Focused group discussion:** focused group discussion were carried out to understand different market actors and farmers insight. Detail FGD checklists were produced.

1.4. Limitations

The study though planned to come up with a comprehensive recommendation, it has limitation due to the scanty literature available on mechanization, as there is hardly any publication written on two wheel tractors. Second, the study was conducted in two districts and important information were collected from FGD with farmers and market actors involved in the sector in the study area. However, the study was limited to make more representative in terms of wider range area and time horizon. Furthermore, since Ethiopia has a wide range of diverse agro-ecologies, institutional capacity, organization and environmental condition, the result of the study may have limitation to make generalization and make the applicable to the country as a whole. However, it may be useful for areas with similar context with the study area.

Chapter two: Agricultural mechanization in Ethiopia

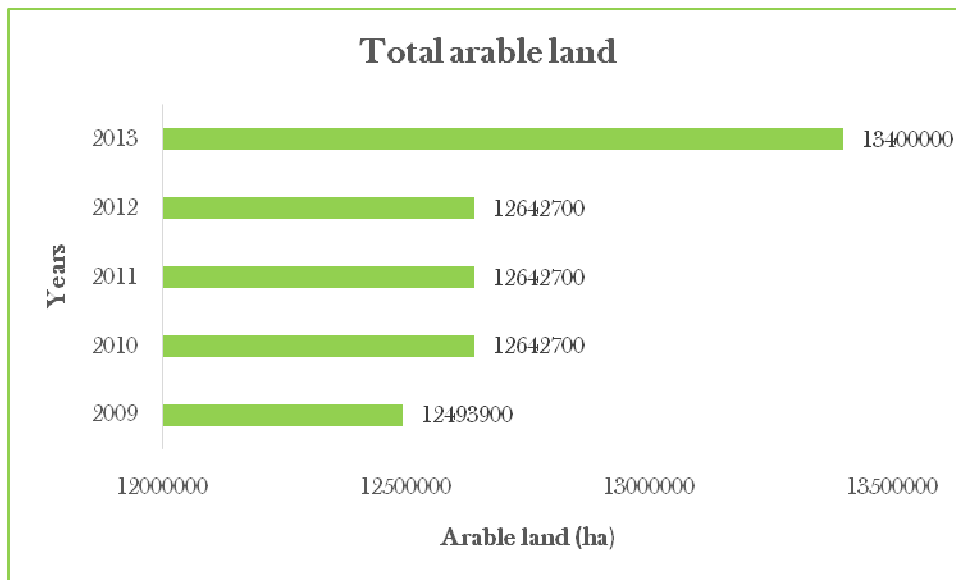
Agricultural mechanization in Ethiopia

2.1. Overview of Ethiopia Agriculture

Agriculture is the second largest contributor to the overall economic growth and a significant contributor to reducing poverty. In 2012-13, it accounted for about 42.9% of national GDP (only slightly behind the service sector at 45.2%) (MOFED, 2012/13), almost 90% of foreign exchange earnings and 85% of employment.

While agricultural productivity in Ethiopia is improving, there are still major gaps in productivity when compared with the rest of Africa in some crop areas, and almost universally, when compared with the global output level. (FAO, 2014). For example, the African average production of wheat is approximately 10% more per hectare, and the global average is about 50% higher than Ethiopia (as detailed Exhibit 1). In countries like China, there have been a significant correlation between increased use of agricultural mechanization and increased productivity. Even with significant improvement in productivity in recent years, Ethiopia is still a net wheat importer. In addition to this, approximately only 12% of the total arable land is utilized for agriculture, with an expectation that this percentage will grow, both in relative and absolute terms.

Figure 1: **Total arable land**



Ethiopia's farmers are also diverse; agriculture is dominated by smallholder farming. There are about 14.7 million households (CSA, 2012), of which about 60%, which operate on less than 1 hectare of ground while only about 1% of farmers operate on land greater than 4 hectares. (PAA-Africa.

2.1.1. Importance of maize

In Ethiopia, maize grows under a wide range of environmental conditions between 500 to 2400 meters above sea level. Maize is Ethiopia's leading cereal in terms of production, with 6 million tons produced in 2012 by 9 million farmers across 2 million hectares of land (CSA 2011/12, Meher season). Over half of all Ethiopian farmers grow maize, mostly for subsistence, with 75 % of all maize produced being consumed by the farming household. Currently, maize is the cheapest source of calorie intake in Ethiopia, providing 20.6 % of per capita calorie intake nationally (IFPRI, 2010). Maize is thus an important crop for overall food security. Maize is also used for making local beverages. Additionally, the leaves and stokers are used to feed animals and the stalks are used for construction and fuel. A small quantity of the grain produced is currently used in livestock and poultry feed, and this is expected to increase with the development of the livestock and poultry enterprises in the country. The green fodder from thinning and topping is an important source of animal feed and the dry fodder is used during the dry season. Moreover, the crop has potential uses for industrial purposes, serving as a starch, a sweetener for soft drinks, an input for ethanol fuel production and oil extraction, etc

As compare to other cereals, maize can attain the highest potential yield per unit area. In Ethiopia the national yield is about 3.0 t/ha (CSA, 2011/12). While significant gains have been made in maize production over the past decade, there remains large potential to increase productivity. From 2001 to 2011, maize production increased by 50%, due to increases in both per hectare yields (+25%) and area under cultivation (+20%). However, estimates indicate that the current maize yield could be doubled if farmers adopt higher quality inputs and proven agronomy best practices. At present, only 17% of maize farmers representing 30% of maize planted area make use of improved varieties of seed (CSA 2010/11), and only 30% of farmers use the recommended rates for fertilizer application.

Ethiopia is already a significant maize producer in Africa, and this role could be further enhanced. Currently, Ethiopia is the fourth largest maize producing country in Africa, and first in the East African region (FAO, 2012).

2.2. Agricultural mechanization in Ethiopia

2.2.1. Status of agricultural 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, in terms of total arable land, dominate crop production in Ethiopia. The introduction of drought animal power

into the smallholder farming system dates as back as century ago. However, in recent years, the use of tractor farm technology is increasingly becoming important among the smallholder farmers at the expense of drought animal. While in the early 1970s only 4% of total smallholder farming households used tractors for ploughing, this figure rose dramatically to 17% and 39%, respectively, by 1980 and 1990s.

2.2.2. Farm Power in Ethiopia

Power use

Level of energy input is one of the key indicator for measuring the state of mechanization. In the figure below shows the available power in agriculture is seen to be increasing gradually

Figure 2: Total hp in the country

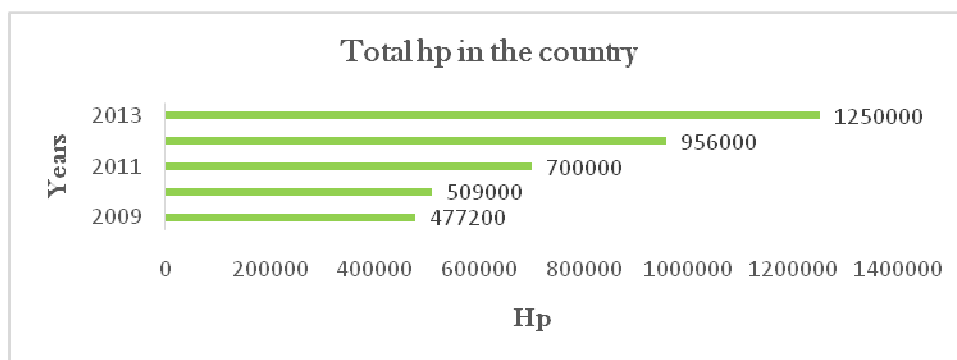
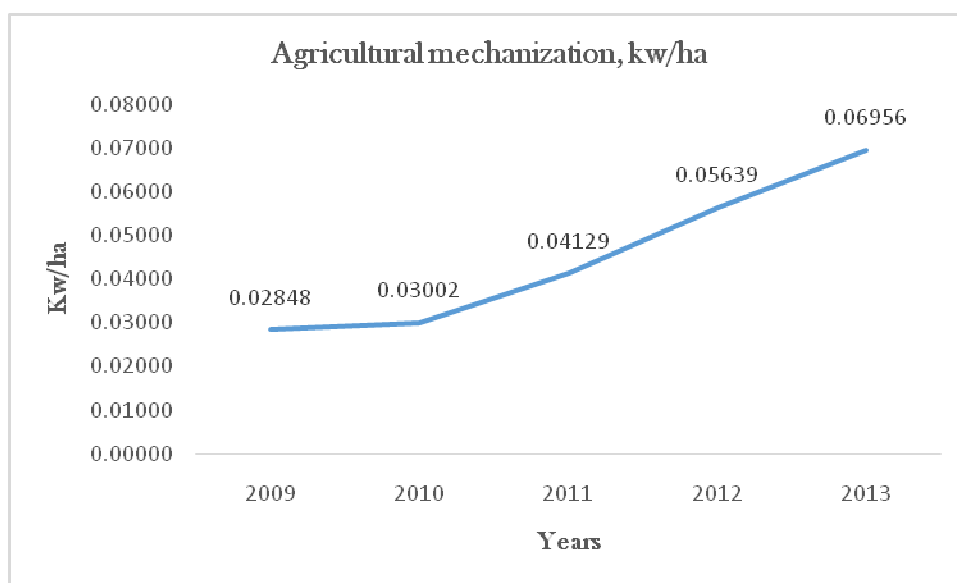


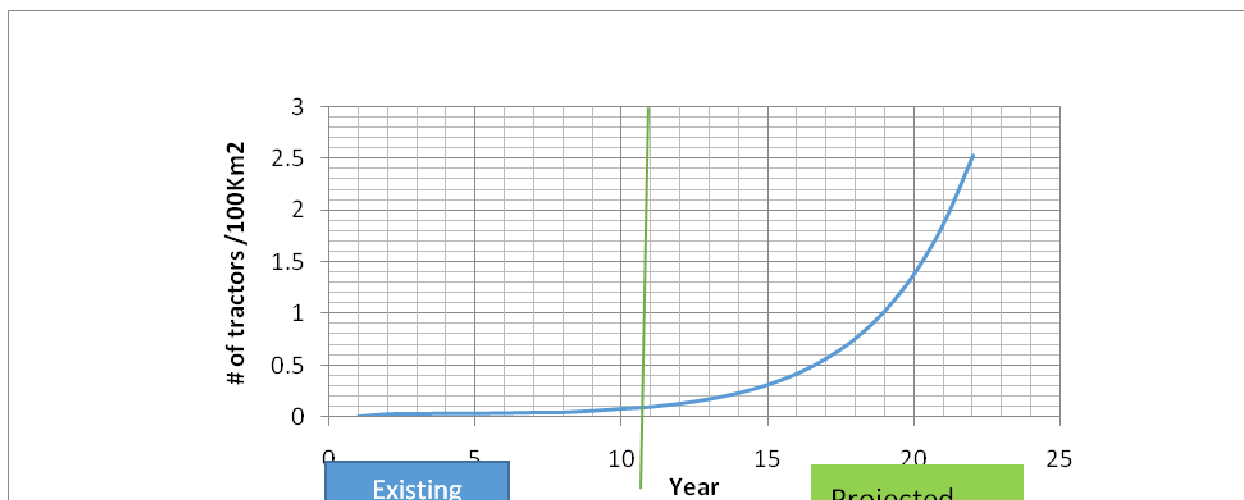
Figure 3: farm power use



Source: ATA

From 0.028 in 2009 to 0.030 KW/ha in 2010 wherefrom it increase to 0.069 KW/ha in 2013. This show in general, the farm power is very low in Ethiopia. As such, the government plan to increase the farm power to the level of 2.5 KW/ha in 2022 as the figure below

Figure 4: projected farm power



Source: ATA

2.2.3. Hand tools and animal draft

Farm power in Ethiopia in general, especially among small-scale farmers who account for about 80 percent of the total farm output, relies mainly on animal traction and human power. It is based on operations that depend on the hoe and other hand tools. Using simple hand tools, a farmer can prepare an estimated 0.5 ha for planting per season. For farmers earn a living from agriculture, they cannot count only on hand-tool technologies since a person as a power unit produces only about 0.01 horsepower of continuous output and is therefore not worth much as a primary source of power (FAO,2010a).

2.2.4. History of tractors in Ethiopia

Ethiopia has a long history of involvement with the 4WT. To nurture agricultural mechanization, state farms both irrigated and rain fed have played a very big role, especially during the second period of “socialist experimentation”, when large mechanized state farms were established totaling about 200,000 hectares, out of which about 47,000 hectares were irrigated. (FAO Vol. 20, 2013)

Another mechanization approach tried in the 70s to 90s period was government operated tractor hire schemes. These were later abandoned; partly due to heavy financial burden on the government as a result of subsidizing the service (Sims, 2006). Furthermore, timeliness of the agricultural operations was difficult to achieve because of conflict among users of the service. Studies on the economic benefits of these schemes were also carried out during this period and it was concluded, based on the various shortfalls identified, that government managed and operated

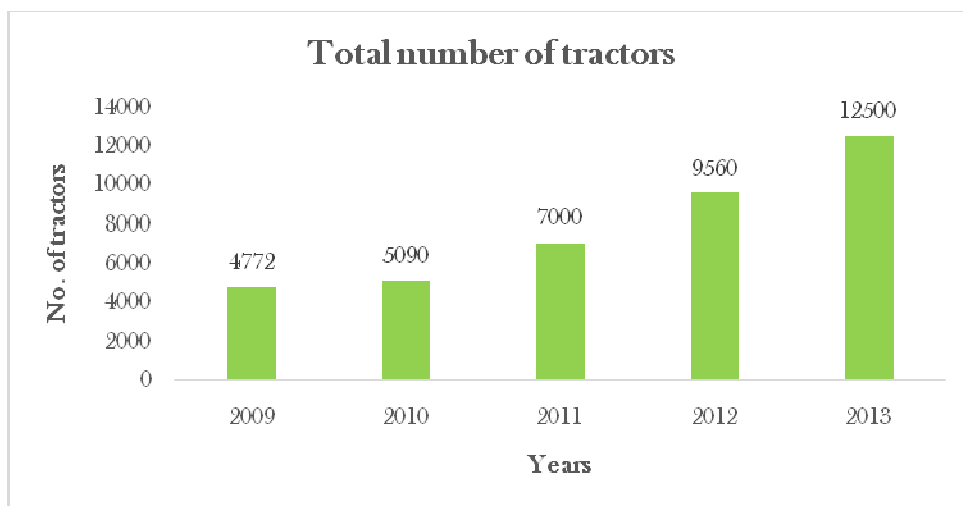
tractor hire schemes were not successful and were consequently largely abandoned in the late 1990s.

In Ethiopia, an estimated 5,090 tractors were in use as of 2010, a significant increase since 2004 when the number was about 3,000. The 2010 figure increases to about 6,000 when “walking” or pedestrian tractors are included. The number of tractors per 100 square km of arable land was about 4.0 and 4.7 respectively with and without the pedestrian tractors. This steady increase in the number of tractors is primarily attributable to the growing number of foreign private investors engaged in large commercial agriculture in Ethiopia, mainly from China, India and Saudi Arabia (WB report, No. 68237)

2.2.5. Tractors and implements

In terms of agricultural technology, tractors are the most important and versatile type of equipment used by farmers wanting to mechanize some or all of their farm operations. Apart from providing an important means of transporting heavy farm inputs and produce to and from the farms, tractors are useful in coupling other motorized and non-motorized implements for the efficient and timely land preparation that is necessary for achieving high yields and minimizing postharvest losses (FAO 2008b). Furthermore, in Ethiopia, because of the problem of dwindling cultivable land area due to population pressure and changes in ecosystems and production landscapes from the overutilization of the arable soil, there is the need to cultivate the marginal and hilly lands to satisfy the increase in demand for food and other agricultural raw materials. Unfortunately, human labor is not adequately equipped to grapple effectively with these changes in ecosystem and production landscapes.

Figure 5: Total number of agriculture tractors imported



Source: ATA

Two wheel tractor (2WTs)

Unfortunately, we do not find any substantial documented information on the use of two wheel tractor except undocumented personal communication in one form or another. An effort to introduce small horse power tractor was started in the 1960s, but did not turn out to be effective. A 12 HP power unit was tested at the DebreZeit experimental station and was reported to have an excellent performance out in the field in the 1960. At different times few single axle tractors were imported by organizations, universities and individuals, but do not find documented works on these machines. Though it has been a long time since they were introduced, it has not taken off from the ground.

These days you see some efforts being done to introduce these machines from different companies. At Mekele, some walking tractors were imported by the University for Research Purposes. About three groups of people had some communication with the Agricultural Mechanization Center to evaluate their equipment imported from abroad. The department has tested the machinery and delivered the reports to the companies. The department appreciates the multi farm use of the equipment, though, did not find them satisfactory when it comes to land preparation. As per the Ethiopian Revenue and Custom Authority recorded data on imports and exported of goods in the country. It has been found that 4132 walking tractors were imported from the year 2009 until mid of 2014 majorly from China.

Implements: this range from simple hand tools to animal-drawn or tractor-mounted implements to condition seedbeds by turning the soil, burying weeds and crop residues, and bringing nutrients to the surface, all to achieve the benefits of weed control, improved soil aeration, and optimized soil fertility, temperature, and moisture. In Ethiopia, 90% of tillage operations in smallholder farming are carried out using *marshal*, a traditional wooden plough pulled by a pair of oxen (Astatke, Airaksinen, & Mohamed-Saleem, 1990), which is not capable of inverting the soil and thus is of little use in burying weeds and crop residues (Astatke & Kelemu, 1993). The moldboard plow, an improved tillage implements developed by the Melkassa Agricultural Research Center (MARC), is designed to address this shortcoming and effectively inverts the soil; use of the moldboard plow has been found to increase grain yield by over 50% compared to *marshal*, and has been demonstrated to reduce required tillage frequency and bury weeds more effectively (Abra, 2001). FAO conducted several trials on small farm implements in the 1950s. The Jimma and Alemaya Agricultural Colleges, also conducted trials on implements between 1955 and 1965. The Chilalo Agricultural Development Unit (CADU) started research on farm implements in 1968 and had some success stories but could not go far.

Row planter: A tractor-mounted or animal-drawn implement used to sow seed in rows at regular intervals, thus helping to control and optimize seed rate and plant density. The use of row planters in Ethiopia is almost at infant stage, and most seeds were typically sown through manual broadcasting. Research in other countries has suggested that potential exists to mechanize

planting using implements ranging from tractor-mounted row planters to animal- or human-drawn small-scale implements. The optimum choice of row planter varies based on environmental conditions, particularly soil type and socioeconomic factors. Hence, further research efforts are required to identify economically and technically feasible row planters for smallholder farmers.

Harvester and thresher: In Ethiopia, most crops are typically harvested by manual uprooting, resulting in loss of quality and reduced nitrogen-fixing benefits due to sticky soils attaching to the roots and being harvested with the crop. After harvesting, the crop is left to air dry, and then threshed on poorly-prepared ground with animals, leading to further loss in quality and the introduction of foreign matter. Mechanizing both harvesting and threshing operations will improve the quality of produce, reduce post-harvest loss, and replace manual labor. Two types of mechanical harvester – the swathe, which cuts crops off at the stem and deposits the cut crops into a windrow, and the combine harvester, which combines harvesting operations of reaping, threshing, and winnowing – may be adopted for different crops. Hence, there will be an increasing need for mechanized harvesting and threshing to meet productivity and quality standards. The cost of mechanized harvesters and threshers is prohibitively high for smallholder farmers, but there is potential to provide access to post-harvest implements through rental schemes administered by cooperatives to members. Further research and technology development efforts are required to evaluate the technical and economic feasibility of adapting mechanized harvesters and threshers in the Ethiopian context.

Chapter three: Market organization & Supply chain actors

3. Market organization and supply chain actors

To understand the overall technology market system for small scale mechanization technology it is useful to understand the key players involved in the system. The sub sector analysis recognized the importance of three major group that have to work together to ensure success. These are the private sectors, service providers and farmers. Each group has a different role to play and represent different interests. For sustainable mechanization, the role of each of these group should be clearly defined and there should be good coordination so that there are complementary.

3.1. Importers/dealers

The private sector has greater role to play in the production, transformation and commercialization of agricultural product. The agricultural mechanization private sector is represented by local importer, manufacturer and dealer. Here in Ethiopia we do have around 12 importers/manufactures /dealers that involved in agriculture machinery business. Some of them are TGT Plc, Kaleb service Plc, METEC, Ries Engineering, Gedeb Engineering, Adeb Engineering, Moenco, Hagbes, AETS, Amio Engineering. On this study I mentioned below in detail those companies that involved in 4 WTs and 2 WTs business.

Kaleb Service PLC

Kaleb service PLC established 22 year ago with a vision to become the biggest manufacturer in the country. The company imports and sells both heavy duty tractors with range of 35-400 hp, combine harvesters and agricultural implements. The heavy duty tractors are CLAAS brand. During the last 22 years, the company imported 1000 combine harvesters which make the company to take the biggest market share in the combine business. So far, the company imports and sold around 12 wheel tractors with 12.5 hp from china and planning to import other brand from Italy. The company provides after sale service like training for operator, maintenances and repairs for damaged components within one year of warranty period. The company imports tractor attachments, forage cutters, trailers, planters, Sheller, threshers, sprayers and harrows. The implements are generally the heavy duty tractors attachment types. Mechanical seed drill, Sheller and multi-crop threshers are being manufactured by the company locally. The company participates on trade fair, demonstration and personal contact as a means of promoting the product and equipment's. The challenges on importation of walking tractor especially from china are unwanted vibration as per feedback from clients and after sale service since Dong Feng brand don't have a sole agent and the tractors are sold in many trading houses.

Adama Agricultural Machinery Industry (METEC – AAMI)

Another major player in the tractor industry in Ethiopia is the Adama Agricultural machinery industry which formerly called Nazareth Tractor Assembly Plant (NTAP), a government factory that is engaged in assembling “semi-knocked down” (SKD) tractor parts. The Nazareth plant was established in 1978 as part of an economic and technical cooperation agreement between the

Ethiopian government and the former Union of Soviet Socialist Republics. NTAP is involved in assembling pedestrian-controlled tractors with 8-15HP, small size tractors with 18-40HP (18, 25, 30 and 40 HPs) and heavy duty tractors with 57, 62, 81, 90, 105, and 130 HP). It is also engaged in the production of simple implements such as disc harrows and disc plows, as well as in the assembly of 6, 8, 10 and 12 ton trailers for haulage and transportation of agricultural inputs and products. During the period NTAP has been in operation, it has produced a total of about 6,000 tractors mostly small to medium sized at the rate of one tractor per day using 3 man-day labors.

NTAP was renamed the Adama Agricultural Machinery Industry (AAMI) in 1992. It was transferred to the Metal and Engineering Technology Corporation (METEC) in 2010. Within the last three years, it is estimated that METEC has imported around 5000 tractors and 3000 two wheeled tractors, increasing the previous estimate to around 10,000 tractors.

So far, more than 1000 of imported 2 WT's have been sold to the regions and Southern region took the biggest share by purchasing 300 walking tractors. The walking tractors are multipurpose models which can plough, harrow, plant, pump water, thresher and transport depending on the accessory attached to them. The industry promotes the tractors and service through mass media, brochures and displays on field and trade fairs. Sales are made both on cash and credit basis.

Agricultural Equipment and Technical Services (AETS)

AETS established 25 years ago with a vision to be a center for agricultural technology transformation in the country by rendering an integrated and customer driven mechanization services, boost up productivity and development of modern farms. Currently, the company do have many functions some of them are importing, distributing of agricultural machinery, implements of tractors and maintenance, technical training and consultancy service. The company do have a total capital of 271,003,316 Birr and imported a total of 4, 832 tractors with different hp, 1000 combine harvesters, 10,000 agricultural implements and 24 two wheel tractors. Out of the 24 two wheeled tractors imported from China in 2013, only 4 walking tractor sold so far and the buyer were also private individual in Addis Ababa. As per the feedback from the clients, they still didn't hear any complaint on the quality of the tractors except one on safety belt breakage.

AMIO Engineering

AMIO Engineering Imported 25 Sifang and 2 Dong Feng china made walking tractor in 2012 and sold 15 of them. The main reason for Amio to bring this two brand tractor was to see their difference on performance and claimed Dong Feng engine is poor and Sifang also need modification to attach implement on the tractors. Sales were made on cash basis. After sale service includes one year warranty period and training for operators. The challenges for not selling all the tractor to clients are affordability and low tillage efficiency. Amio also imports ploughs, trailers, harvesters/reapers, planters, pumps, Sheller and forage cutters. The company maintains fast moving spareparts from stock. Problems mentioned include: low market demand,

low comfortableness of tractors, no proper skill and training for operators to operate the tractors, no quality control system. Amio Engineering do have experience working with iDE Ethiopia on voucher system on providing subsidize water pump for unions. They believe 2 WTs do have a potential to scale up in specific area but all depend on soil type and awareness creation for clients.

3.2. Service Providers

3.2.1. Union/Cooperatives

Hitossa Farmers' Cooperative union

The union covers 7 districts in Assella area with a total members of 62 cooperative and 55,000 farmers with a capital of 34 million birr. The union has a farm mechanization business giving tractor hire scheme for the members of the union and to any interested individual farmer. Currently, the union do have 6 four wheel tractors and 4 combine harvesters. They are closely working with Kalab Plc on purchasing the tractors and combine harvesters. The union believes tractor hire scheme is a profitable way of income generation and planning to expand the service a lot by having a lot of 4 WTs. So far, they never tried using 2WTs because of lack awareness on their performance and a deep need for higher HP tractors because of soil type in their area. Though the union have never bought and used 2 WTs, they are willing to work on this business if the farmers in their area accepted the technology.

Sidama Alto Farmers Cooperatives Union

The union have 87 member cooperatives and total capital of 6 million birr. The unions don't have any experience on tractor business but they are the major input supplier of seed and fertilizer for the Sidama zone. The union do have some experience on agricultural equipment on Sheller and planter. However, they are willing to go for 2 WTs business, if there is a proven technology suitable to their locality and if financial institution are willing for the union to give credit to work on 2 WTs for the farmers.

3.2.2. Ethio-German Agricultural Training Center (ATC)

ATC at Kulumsa which started operating in 2011 has been established in the context of technical cooperation between MoA and German government. As per the cooperation agreement, ATC is mandated to provide advanced training for operator, technician, mechanics, farm manger, agricultural business leaders and service provider in agricultural mechanization. In this case, ATC is intended to improve the knowledge and skills of the workforce engaged in in the area of agricultural mechanization. So far, they trained 1773 individuals in different disciplines but they never gave 2 WTs training to anyone. The training is provided on cost share with the firms to cover fuel cost, allowance and accommodation to the trainers.

3.3. Farmers

Farmers in the district are not the user of agricultural mechanization technologies. Most farmers in the district own 1-2 hectares, where most own about a hectare. Oxen and hand tools are the main source of power but all farmers do not have a pair of oxen, in this case, they share and do the work turn by turn. However they think that walking tractors could have a better chance of diffusing in their kebele because of lack of power, small land size and light soil of their farm. Here, tractors are not know very well. As such, awareness should be created and start with evaluation and demonstrations of the technology to the community. Beside this, operators and maintenance and repair service training should be handled by upgrading the local skill.

Model farmers

Most of the model farmers in the district predominantly use oxen. Ox is the main source power source. They all do have little or no experience on using tractors. Some of the farmers that used tractor found in Assella area are linked with the union and private contractors that provide tractor hire service for the farmers but mostly the service providers are not willing to give the service to the small number of farmers area due to small number of clients, small plot of land and topography of the area hinder them not to use tractor services. Concerning 2 WTs, none of the model farmers are aware about the walking tractors expect one model farmer in Assella, which he tried and failed due to heavy soil and not being trained properly on how to operate. On the other hand, tractor is not known well in Hawassa zuria woredas, it seems like willingness to accept the technology, soil type and topography of the areas might give a possibility for the commercialization of 2WTs better than Assella area but above all, awareness creation and demonstration and a lot of field days is expected to bring the model farmer into agricultural technology system.

Women farmers

Most of the women group that we had a discussion do have land holding ranges between 0.5 -1.5 hectares but the majority own about 0.75 hectares/household. Land preparation is effected using manual labour and oxen. The first and subsequent plowing are using labour by hiring farmers for these services. Women farmers never used tractors because of unavailability, small and fragmented land size. As per the discussion, what we found out was the farmer's willingness to see and use two wheel tractors once the tractors is proven to their situation. Here, thought the cost for 2WTs may be high, the group will find a way to have tractors by organizing in group to share the burden of the cost and fairly distribute the service but threat for sharing machinery in group was raised by the women group.

To categories farmer in to two groups based on using mechanization and without mechanization.

Farmers without mechanization

For those interested, they outlined the advantage as follows:

Tractors cultivate on time since most of them miss the season of planting due to the delays in tilling as a result of using hoes; reduced labour cost since they have to use other hired labourers who are scarce presently due to rural-urban migration; these machines till deep into the soil which brings up the fertile soils that otherwise wouldn't be attained by using hoe; facilitate easy management and supervision of agricultural activities; reduces human labour; increase production. However, anticipated some constraints as lack of skills to operate and maintain them; failure to acquire spare parts in case of break down and limited financial capacity to purchase these machines.

Farmers already using mechanization

They identified similar advantage that increase production as a result of speeding up cultivation and being able to cultivate a bigger area as compare to the use of traditional methods. The constraints faced by these people include: lack of spare parts and maintenance and repair services

3.4. Maintenance and repair services

Solomon Garage in Assella

Solomon garage in Assella give maintenance services to vehicles and agricultural machinery like tractors and combine harvesters. They maintain disc ploughs, combine harvester, which are basically cutting, welding and part replacement. They do have cutting, grinding, welding facility including lathe machine, which they use for making modification using turning, pressing, bending, facing and thread cutting work. The garage has the experience to undertake everyday occurring maintenance work on any farm machinery, which has the potential to do similar work on the single axle tractors. They don't have any set price for the service but mostly based on negotiation between the garage and service seeker. Depending on the work volume, preference could be given to usual customer and attractive business. The garage works on direct cash payments bases. The garage claimed the more vehicle and machineries being brought to the district, the work volume is increasing and business is growing. The garage work force has developed the skill through long years of experience not on formal training.

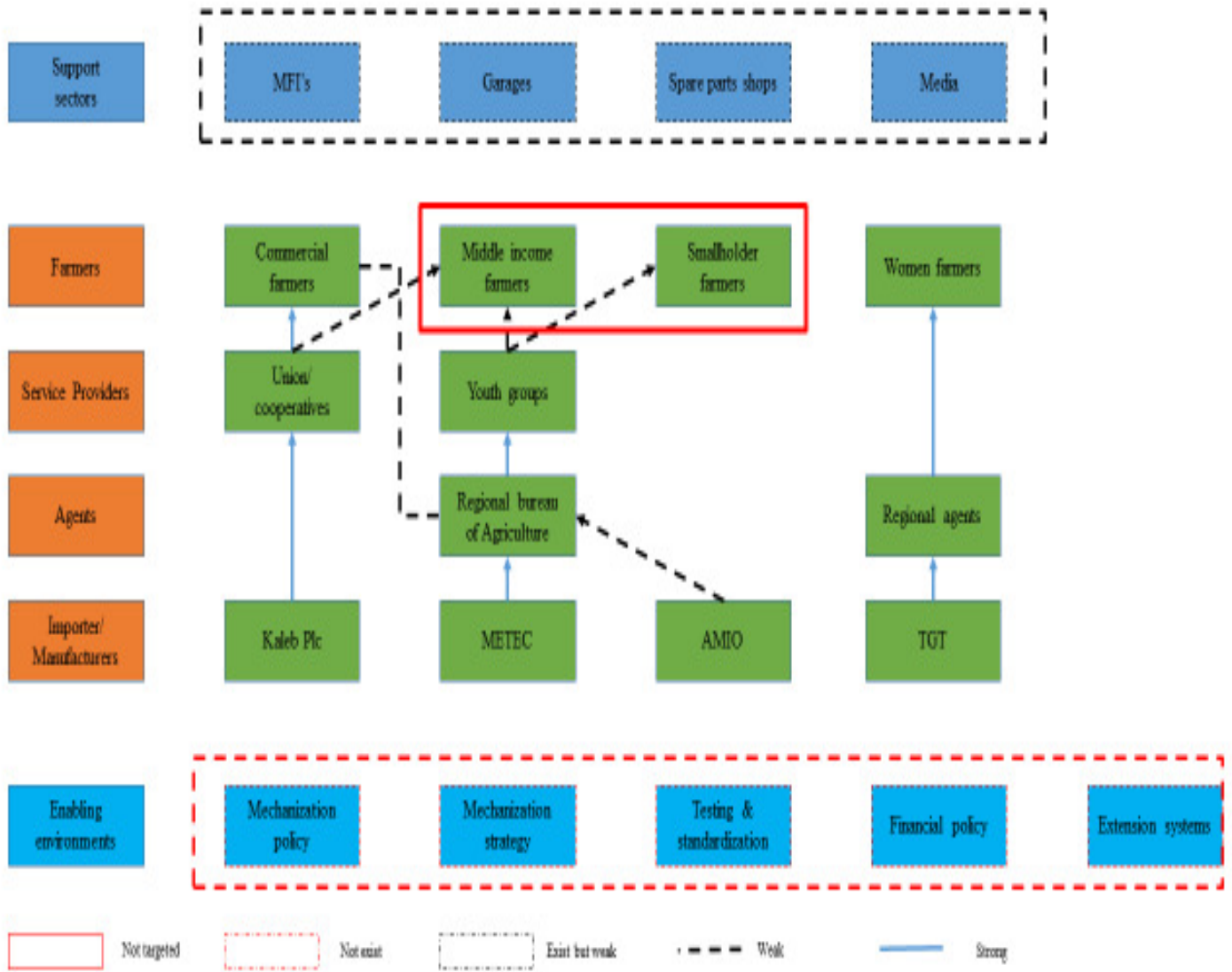
OMEGA Automotive Engineering Service

OMEGA maintenance garage organized by five individuals comprise of two mechanical engineers, one qualified mechanics and two economists. They maintain vehicles, high transport machines and small and heavy tractors. The garage has signed a memorandum of understanding with METEC tractor industry and had taken training and after sale services on the METEC tractors. However, after signing the MoU, nothing has been done on tractors maintenance with METEC. As they took the training from METEC, they are maintaining METEC assembled tractors in different area of the region that are already purchased from METEC by other programs. They underline the problem of theses tractors as they do have some issues on quality, spare parts and on time delivery. They feel that parts are critical and mobile service are essential to handle things smoothly and to avoid down times. The garage is capable of giving training,

service and other technical backstopping for the two wheel tractors in southern region and our intervention areas.

3.5. Agricultural mechanization mapping

Agricultural mechanization mapping



3.7. Gender implication

Women constitute half of the rural farming community in Ethiopia, contributing 48% of labor overall agriculture, and 70% of household food production. A number of studies indicate that investments in women's access to agricultural inputs and agronomic practices can bring up to a 30% increase in production. Similarly, addressing gender inequality at the national level can contribute up to a 1.9% increase in GDP. Further, investments in women farmers' productivity and income has a ripple effect on improving household nutrition, children's schooling, and the ability of the household to make further investments through nest egg savings. Realizing this fact, the national Growth and Transformation plan has clearly underlined the need to involve both men and women, supporting women's institutions and targeting at least 30% female-headed households (FHHs) in all extension services.

Agriculture mechanization has 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 reduce women's workload and facilitate difficult operations. However, experiences in many countries show the promotion, adoption and benefits of mechanization are not gender-neutral. Mechanization technologies have mostly been adopted in relation to men's tasks – often with negative consequences for women. But detail assessment and analysis is needed to know how labor-saving technology are most expected to be most impactful for female farmers because they work on do both on-farm activities and household activities.

Chapter four: Dynamics of the market

4.1. Existing demand

Ethiopia does not have tractor industry except the single government owned cooperation i.e. Adama Agricultural machinery Industries involved in assembly of tractors.

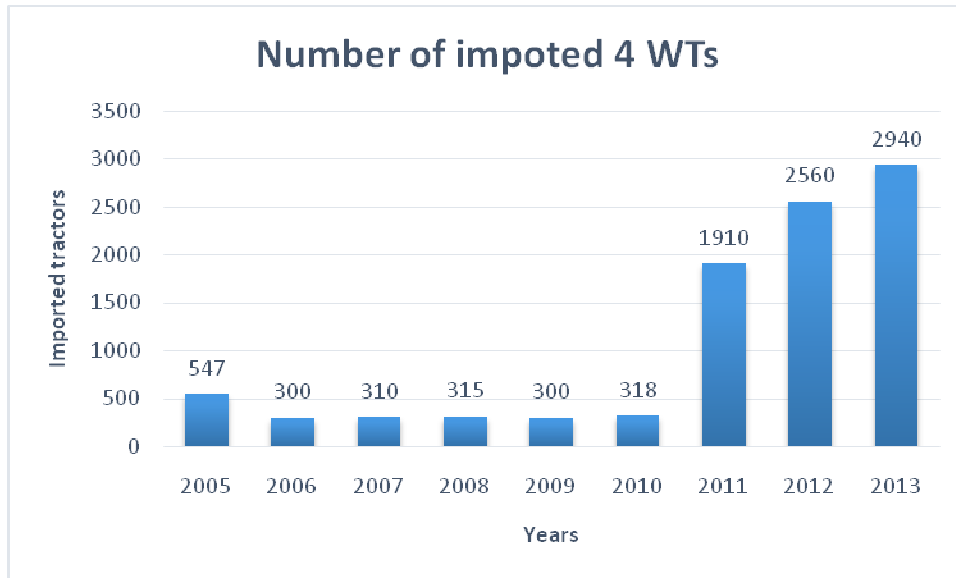
Over the last four years, particularly since 2011, the use of various types of tractors has shown a definite increased trend. Reasons are many, namely, increased attention of government for commercial farmers, availability of financial support for investments, increased foreign direct investments and export, etc.

Most typical character of Ethiopian tractor sector is that there is a wide variety of brands and the countries of origin mainly include countries like, China, Italy, Poland, Germany, India, Netherlands and USA.

Four wheeled tractors (4 WTs)

Currently there are more than 12,500 four wheeled tractors in the country owned by both private and public sectors. There is an increasing trend in the number of farm and agricultural equipment/vehicles due to increased application of modern tools and techniques in farming and agricultural production. Nowadays, agricultural tractors are being used in the rural areas by commercial farmers and cooperative unions more frequently than the past. Traditional oxen based cultivation method is giving away to mechanized farming in the some part of rural areas of Ethiopia. One of the key elements that made this possible is the interest of government for private sectors to involve in commercial farm and government mega projects like sugarcane production. But a lot is expected from government on availing lease financing facilities in the country and allocating large amount of agricultural credit funds. It has been observed that there is a promising growth in the number of agricultural equipment every year. This growth rate will continue to increase in the near future especially if the government develop different policies and strategies relating to agricultural mechanization sector.

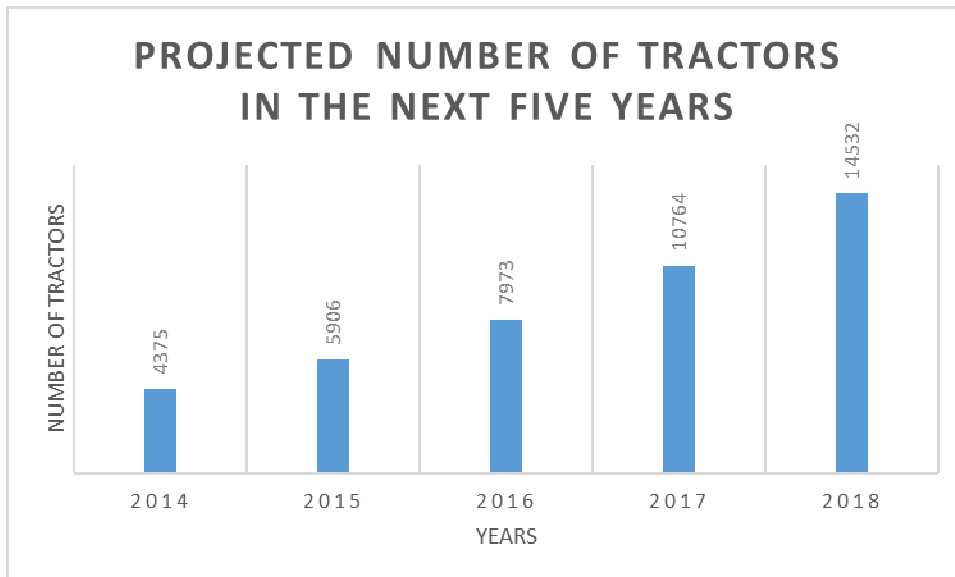
Figure 6: Number of imported 4 WTs



Estimated demand of four wheeled tractors

Taking into consideration the future prospects and also keeping the present growth pace influenced by various elements discussed earlier, it is expected that there would be an additional increase in the use of tractors for the next five years.

Figure 7: Projected number of tractors



Two wheeled tractors (2 WT's)

There are reports of the scattered existence of 2WTs in Ethiopia, but few farmers/groups are using 2 WT's for farm operations. Having the right quality of tractors at the right time for an

affordable price will not automatically lead to an increase tractor use. Most farmers are still subsistence producers with little or no knowledge of inputs. They do not produce enough marketable surpluses to invest in inputs and are not familiar with the concept of 'farming as a business' in which the use of tractor is a cost versus return calculation. Currently, it's believed that there are around 4,132 two wheel tractors in the country owned by public and private sectors. The majority of two wheeled tractors are imported by Government Corporation called METEC, which imported 3,000 Dongfeng brand from China and the rest are imported by private sectors like AMIO, AETS, TGT and Kaleb. However, most of the imported tractors by government and private sectors are not sold and demand is low due to lack of promotion, demonstration and affordability issue.

In Ethiopia, tractor recommendations are outdated especially for smallholder farmers. The use of inappropriate farm technologies has led to low return on farmer investments, and reduced farmers' confidence in national extension services. Updated recommendations and farmer training on tractors use are essential, but national research and extension systems in Ethiopia have been weakened by lack of funding for agricultural mechanization. A number of development partners have tried to introduce initiatives to increase farmer access to and use of tractors. Many countries have also introduced tractors subsidies, thus minimizing the financial burden to invest in tractors. When combined with subsidy programs, interventions have dramatically increased tractors adoption rates in other part of the world like Bangladesh. Alternatively, micro-credit fund for agricultural machineries and machinery leasing programs have also made it possible for farmers to access tractors.

Stimulating tractors demand

A conducive policy and institutional environment is critical to stimulate tractor use in Ethiopia; national policies should be in place to create the market conditions necessary to foster a competitive and sustainable private-sector led tractor market. The key components of such a policy framework are: a stand-alone mechanization law that establishes a clear and efficient process for the governing and operations of the mechanization market; enforcement of the law through a clearly-defined regulatory body; abolition or at least minimization of tariffs and taxes on tractors to allow companies to better predict the cost structure of machineries and keep prices low for farmers; a clearly articulated and predictable tractors subsidy policy at least for the beginning; provisions to improve credit availability for agricultural machinery suppliers and farmers; incentives to promote local manufacturing as appropriate to support the tractor supply chain. Output markets, which generate the revenues that enable farmers to invest in tractors, are the major driver for expansion of tractors consumption are a must to have for the promotion of agricultural technologies to the smallholder farmers.

4.2. Market performance

Structure of the two wheeled tractor market

The tractor market in Ethiopia is almost 100% import based. Even, there is no quality local manufacturer of spare parts and components. The market of tractors is very small but expanding rapidly.

Elements of structure	Market Environment	Effect on utilization of two wheel tractors
Number of buyers and sellers	One strong seller (METEC) , but more than three willing to go to the businesses as Kaleb, TGT, AETSC, AMIO	Traders are obliged to offer attractive condition as the volume is too low to get to full-fledged business Once the business is in full swing they are bound to fix prices
	Government affiliated buyers Research oriented buyers	As there are few buyers, conditions tend to be favorable to attract buyers
Barriers to entry to the market	Farmers lack access to credit and awareness about the technology	
	Importers pay high duty	
Integration	Famer's group are not organized around two wheel tractor utilizing scheme	Farmers tend to pay high as ownership is on individual basis

Market elements

The tractor market in Ethiopia has been dominated by the government corporation and some private sectors. The government corporation play significant role to meet the demand and supply and occupy a large market share in comparison to the private sectors. Over the last five years, some private importers have enter the local market but the government corporation dominated the business. From observation, some believe that, there is still a large market for the private sector importers, if they come up with innovate business models to reach to smallholders.

Elements of conduct	Environment	Impact on two wheel tractor marketing and CA
Who sets the price	One or two dealers deliver the technology on order basis	The price are high though products are of high quality,

		have failed to attract buyers
	METEC sets the price and mode of delivery (Government)	Prices are paid on installment basis and has attracted substantial buyers though dominated by the public sector Unless this generates enough buyer, this will be a self-defeating exercise
Buying and selling practices	Consumer prices are not transparent and tend to fluctuate even within a short period of time	
	In case of METEC prices are transparent	
Other conducts	Training is provided	
	After sales service provision is not transparent	
	Guarantee is not transparent	
	METEC looks as if it has backing of the policy environment	Quick impact on uptake of the technology, but may monopolize as time comes along

Chapter five: Mechanization service and enabling environment

5.1. Current demand and supply for service

Tractor hiring service

To assess the ease of obtaining tractor services in Ethiopia, the availability of tractor rental services and the cost of plowing farm land in the country needs to be examined in detail. But as per the data from field survey and literatures, few tractor rental services exist in Ethiopia. Apart from the Agricultural Mechanization Service Enterprise (AMSE) of Ethiopia that is located in the capital city of Addis Ababa, most of the plowing services are provided by the cooperative unions and by a small number of very large commercial farmers/entrepreneurs who rent their tractors to other farmers in neighboring communities. Currently, the Agricultural Mechanization Service Enterprise (AMSE) had about 70 tractors in fairly good working condition and only four service centers throughout the country although it has a mobile workshop that is well equipped to travel to all corners of the country to service the tractors when the need arises. Most of the tractors owned and operated by AMSE are medium-sized tractors with engine capacity of between 80 and 120 HP. Farmers point to the apparent lack of tractors and tractor rental centers as major limitations to agricultural mechanization on their parts. As a result, those who do use tractors have to pay in advance and endure long waiting periods for tractor services, a situation which is apparently especially acute for wheat farmers. For farmers with half a hectare or less, tractor services are generally not available. The survey found that the average cost of disc plowing in the survey area was an average of 1,300 birr for the first plowing from private tractor service providers and 1,200 birr from the cooperative unions. For harrowing and second plowing, the costs were ETB 650 from the private sector and ETB 600 from the cooperative unions. Though the demand for tractor hiring service is higher than the supply, we observed that cooperatives /union limitation for outreach and having only small number of tractors. For example, Hitosa Cooperative union covers 6 districts with a total members of 50,000 and has only 6 tractors. This made most of the farmers not to use tractors or pushes them to look for other options.

On the other area, especially around Hawassa area, youth groups are organized by the regional job creation agency to provide hiring service for farmers using 2 WTs but no data available on the demand and supply of their service for the community.

Demand and supply obstacles in mechanization hire are a major hindrance to widespread use of modern farming technology for increased agricultural production. They include high cost of hiring mechanization services, shortage of quality machinery, inadequate maintenance service and expertise, poor quality of spare parts, fluctuation in fuel prices, and inadequate knowledge among smallholder farmers about benefits of mechanization, fragmentation of crop area leading to high cost of mechanized cultivation, and most significantly demand and supply deadlocks in mechanization hire. Moreover, smallholder farmers generally lack the understanding, unity and initiatives to get self-organized to address their various needs and challenges towards increase agricultural production.

Tractor spare parts demand in Ethiopia

As the country have no tractor industry, the sector is totally depended on import, except a few tractor-assembling units. Every year number of tractors is increasing due to increased requirement and demand. The sector has growth potentials.

Consumption of tractor parts depends on several factors. There is a numerous types of tractors parts being used by different types of tractors. Some parts have very short usage time and some have longer usage time. In Ethiopia, since there is no tractor manufacturing plant, there is not enough producers of spare parts.

As such, the total demand for parts and components will increase in future because of increased use of tractors on farm fields, which has to be met by local manufacturer and import.

5.2. Financial Institutions

Oromia Saving and Credit Share Company (OCSSC)

The Oromiya Credit and Saving Share Company is operational only in Oromia region. The branch office in Assella is operational in all of the 19 kebeles providing basic services like saving, credit, insurance and advisory service to the community. The MFI has about 4000 clients in the woreda with 2641 men and 1359 female. Currently, the MFI is giving two types of loan for individual and group based loan, where a group comprises of 5-10 member and become guarantee to each other's. Here, the maximum loan amount allocated to individual in a group base is 15000 birr. So far, the MFI do not have any experience on provision of loan for purchasing agricultural machinery like tractors and ancillary equipment. But if the Woreda bureau of agriculture or any NGOs become a guarantee for the loan, the MFI is ready to consider the loan with a special loan scheme.

OMO microfinance

OMO microfinance is operational in the whole region of Southern Ethiopia. The MFI do have a total capital of 4 billion birr and 500,000 saving members and 300,000 credit user members. They do have 3600 credit and saving extension agents in targeted areas. They do give credit and saving business based on the business plan. In rural area, if the farmer need to get credit, what is required from them are land certification and support letter from their local BoA office.

Sidama Microfinance

Sidama microfinance is operational in 21 woreda of Sidama Zone. The MFI started as a saving organization comprise of 60 women in 1998. The MFI is established with the support of ZidamaBuraue of Agriculture and Irish aid. Currently, the MFI do have 24 branches and 4 sub branches. Its main function are saving and credit. It was meant to avail credit facility for rural area especially for women. They provide group loan for the members organized in to 5 individuals to guarantee each other without collateral. Here, the group loan can go up to 90,000

birr and individual loan from 3000 to 20,000 birr. Some of the criteria to get loan from Sidama MFI are age, clearance from loan of other MFI's and group collateral.

5.3. Enabling environment

An enabling environment is an essential requirement for the development and expansion of the mechanization sub sector. Improving the business environment must cover all stakeholders involved in agricultural mechanization. It is brought about by putting in place an enabling mix of the different policy that directly or indirectly affect the sub sector. For the agricultural machinery sub sector, favorable environment is one which allows the creation of a free market based on fair and undistorted competition in which transaction cost can be kept low. The government represented by Ministry of Agriculture (MoA), Woreda bureau of agriculture and Rural job creation Agency is responsible for the creation of an enabling environment that would enhance agricultural mechanization. They therefore play a major role in the Sub sector especially developing in policy, strategy, and testing and certification for agricultural machinery imported in the country

Ministry of Agriculture

The Ministry of Agriculture is responsible for developing the overall national agricultural and rural development strategies and policies for Ethiopia, with input and support from the regions and other stakeholders. Within the MoA, the recently established Mechanization Directorate oversees the agricultural mechanization program. The Mechanization Directorate is coordinating and formulating the implementation of the mechanization strategy in collaboration with its regional counterparts. In addition, the MOA Mechanization Directorate is taking the leading role in organizing joint planning, monitoring and evaluation sessions to align all stakeholders over the sector strategy. The MoA's continued engagement on the agricultural mechanization – both through the Mechanization Directorate and other directorates (Input, Extension) will be essential for the success of the agricultural mechanization sector. The **Extension Directorate** oversees services used to promote and popularize new technologies and practices through the public extension system. The Extension Directorate works closely with counterparts at the regional, zonal and woreda bureaus of agriculture.

Sidama Zone Rural Job Creation Agency

The agency is responsible on creating employment opportunity for the unemployed youth in the rural area especially for university and technical vocational graduates. So far the zonal agency established around 98 association which are organized in 15 different sectors. One of the sector is farming for the youth. The region linked with METEC and procure 300 walking tractor. Out of the 300, 297 distributed to the different zone the region. Out of this, 20 walking tractor allocated to Sidam zone and the agency distributed to 5 districts in the zone. As per the feedback from the field experience, the tractors are not well functioning because of not enough back stopping and proper training to operators. So far, the agency didn't conduct any assessment to monitor the

performance of the walking tractors but they are planning to do it soon before purchasing any additional tractor from METEC

Chapter Six: Constraints and Opportunities

6.1. Constraints

The advancement of agricultural mechanization has faced a number of distinct challenges. These have constrained both the widespread availability of such machineries on supply level, and ultimately, the use of those implements in agricultural production, especially in the smallholder context. This has greatly reduced the potential impact of agricultural mechanization on production across the agricultural sector, and indeed has limited its use in larger, commercial farms and few selected area where it has been disseminated through informal channels. The causes of this are many, but there are a few cross-cutting constraints that have been particularly restrictive and have limited farmers from benefiting from the advantage of agricultural mechanization. To mention some of the significant constraints

Figure 9: Constraints of small farm mechanization

- Lack of mechanization strategy
- High tariff on imported agricultural machinery
- Lack of effective demand creation
- Lack of geographic presence
- Farmers are not sufficiently aware of technology opportunities
- Farmers lack regular access to technology basic services
- Topography and soil type
- Lack of maintenance and repair services
- Insufficient skill throughout sector
- Farmer do not receive reliable information and advice
- Farmers' lack of confidence in output markets reduce adoption
- Poor access to effectively forms of credit
- Lack of holistic view of the full market system

6.1.1. Mechanization strategy

The mechanization to be effective there has to be strong and effective strategy along with proper policy that lay favorable ground for its implements. Up until now there is no agricultural mechanization strategy that governs the proper development of the sector. Accordingly, poor planning by government agencies and on – off, aid-in-kind efforts are dominated. Recently, following the recent high demand for improved agricultural mechanization technologies, different firms are engaged as various dealers and users of machineries. In this regard testing of imported agricultural machines and implements should be given high emphasis to assess their functional performance, suitability under different agro – climatic conditions. Otherwise introduction of inappropriate implements, apart from their poor performance will result in loss of confidence in improved implements by farmers.

6.1.2. Repair and Maintenance services

Machines and implements require servicing and maintenance to prolong their useful life. The repair and maintenance service in Ethiopia is limited. Assuming a proper and routine maintenance, a tractor in Ethiopia can deliver up to a maximum of 30,000 engine hours, with an average 1,750 engine hour per year for 8.9 years. The life span is reduced for locally assembled machinery or imported one from India and china to an average 5.5 years (Agribusiness report 2012). Thus, agriculture mechanization will not be successful if the local economy is unable to deliver services, fuel and spare parts for either imported or domestically produced machines. This failure often occurs when markets for these items are fragmented or unevenly developed or when new models or different brand of machines are imported without considering the need for the spare parts. Up until now, there is no proper strategy for introducing mechanization technology in wider scale by the extension system. Moreover, curriculum in ATVETs and FTCs do not include agricultural mechanization unlike other disciplines such as crop, livestock and natural resource management. Consequently, personnel working in the extension area fail to understand most of the technology being pushed by the research or introduced from somewhere else. Also, unlike the other inputs information available on agricultural mechanization technologies is quite limited. This could be attributed to the attention given so far and capacity available at all time.

6.1.3. High price due to tariff on imported agricultural machinery

At least for short term, importing is most viable mechanism but the system is unattractive to the private sectors involved in this sector. Today, tractor imports are exempted from taxes and other duties provided they are cleared from custom and bought by the customer within six months. If the customer misses the six month timeline, a 10% custom duty and 15% VAT are then levied on the tractors increasing by 25% the original price of a tractor and subsequently limiting the use of tractor. Similarly, spare parts for tractors are tax free upon the condition they are imported at the

same time with tractors. Subsequently, spare parts imported separately will be taxed 5% custom duty, 15% VAT and 10% sure tax. Adequate provision of spare part is critical for keeping machinery operating productively, with the current tariff is contributing to inadequate supply of spare parts thus poor maintenances of tractors and high cost. This makes the price of tractors and spare parts to be expensive and put burden on clients.

6.1.4. Farmers lack business skill

Traditionally farmers don't consider their farm business as a business due to lack of concept for the business ideas. As such, they don't calculate the benefit and loss for their business and not strive to test new technology to improve their farming. Mostly, this is due to lack of awareness or the extension system is not pushing the farmers to improve business skill and farming with new technology.

6.1.5. Lack of effective demand creation

Though the number of private sector involved in the 2WTs business are small and few, the initiation or interest to create demand on the 2WTs is less or poor because most of them want to work on the existing system of 4WT business. As such, most private sector businessmen willingness to intervene to the 2WTs business at this stage is minimal or only some are willing to start from the scratch or they need some other actors to play the facilitation role for the demand creation. Even on the 4WTs, given the limited number of companies, bulk supply of tractors is limited. Currently, importers are importing machineries based on demand. They don't have the capacity to import at scale and push their product to farmers.

6.1.6. Lack of geographic presence:

Proximity to clients is imperative a successful distribution channel. Importers are typically located only in the capital city, meaning they are not able to reach smallholder farmers in rural area. This means end users must travel long distance to access agricultural machinery, spare parts and repair and maintenance. Only few of the importers do have mobile workshop providing the service at farm level. Moreover, to establish an agent/dealer at regional level with joint venture with regional private sectors require technical, business knowledge and financial resources. However, there is a limited skills on agricultural machinery and typically require a larger financial investments to buy the agricultural machineries and set up workshop facilities.

6.1.7. Topography and soil type

Many farmers are operating on land that is smaller than one hectare, which is sloppy and of reduced usability. As a result of this sloppy nature, as well fragmented land, there is often a lack of easy/consistent access by machinery to farmers' land. This prevents machinery being used economically across multiple farms.

6.1.8. Lack of access to finance and financial service for agricultural machinery

Tractors are costly and are not financially viable for the majority of smallholder farmer depending on the size, type and brand of tractors to have it individually. One of the main reason is low income of farmers: farmers' small plot of land and low productivity limit their purchasing power and on the other hand, Microfinance involvement in the agricultural machinery is very limited and lack of flexible credit service were identified as farmers' largest constraints.

6.1.9. Insufficient skill throughout sector

Skills are crucial for ensuring technologies can successfully adopted through the commercialization system. Particular skills are required in the area of business-planning, marketing, promotion, and risk management to ensure that the system performs more efficiently. As per this assessment, there are capacity issue in the private sector, notably in understanding how to form partnerships with different market actors and in demand forecasting. Beside this, the service provider at local level don't have substantial knowledge and skill on how to operate the machineries, repair and maintenance. Plus, the manufacturers/importers do not provide "after sale service" to the users. We also find out as machines left out without working for minor and easily repairable faults. On availability of artisan or a mechanic, the service provider get them repaired at the expense of high charges. But in other cases, where mechanics are not ready available, they leave the machine without operation. It is because no one in their village or community trained and lack of adequate knowledge and skill about the machineries.

6.1.10. Farmers are not sufficiently aware of technology opportunities

Field survey revealed that farmers were insufficiently aware of opportunities to access or adopt new technology. The disproportionately high risk attached to adopting new technology for smallholders farmers means that a high level of trust and confidence must be developed in order to achieve successful technology adoption. This trust and confidence can be developed through a high level of awareness and promotion about the benefits of a particular technology but here farmers lack access to clear and trustworthy source of information about the new technology uses and performances.

6.1.11. Farmers lack regular or optimal access to technology basic services

Technology services are demanded particularly by low-income farmers and women farmers that are female headed households, as they cannot afford many of the more expensive mechanical technologies. Even if the technologies are affordable there seems a tendency of farmers to prefer for technology rental since the technology required is used only infrequently, as this saves on storage and maintenance. However, Tractor hiring service models were not observed in the districts and farmers do not have access to technology based service. Key reason for this was found to be that often no local service providers are operating proximate to low income farmers and more remote farming communities. The union in Assella that provide service for farmers were giving to some of the member of farmers and rich farmers in the community. Even if these

farmers group need the service, yet due to the high number of farmers requiring service at peak time and the one local service provider in the district, they often have to wait long time to get the service. This poor access to technology services was understood to due to a number of actors. These include that: small number of tractors by the union; only focusing on 4 WTs and combine harvesters; lack of skill to repair and have to seek support elsewhere (such as operating, spare parts, technical knowledge, maintenance and repair).

6.1.12. Inaccurate demand forecasting information

Demand forecasting is a key element of any business projection, information regarding the demand for products and services enables companies to promote their products, expand into new market and launch new technologies. A number of reasons were highlighted to explain inaccurate demand forecasting. These includes: lack of capacity in the private sector to effectively gather information from farmers; inconsistency access to government data at national and local (district) levels; not having clear policy and strategy for agricultural machineries.

6.1.13. Farmers' lack of confidence in output markets reduces adoption

The security of the output market is a key factor determining the uptake of technologies by farmers. Secure output markets increases farmers' investment in new technologies as if farmers have increased security they can plan more effectively for the upcoming crop. Where there is a large market and farmers need to produce quickly it is more likely that they will seek access to new technologies to drive production and enable then to meet this demand.

6.2. Opportunities

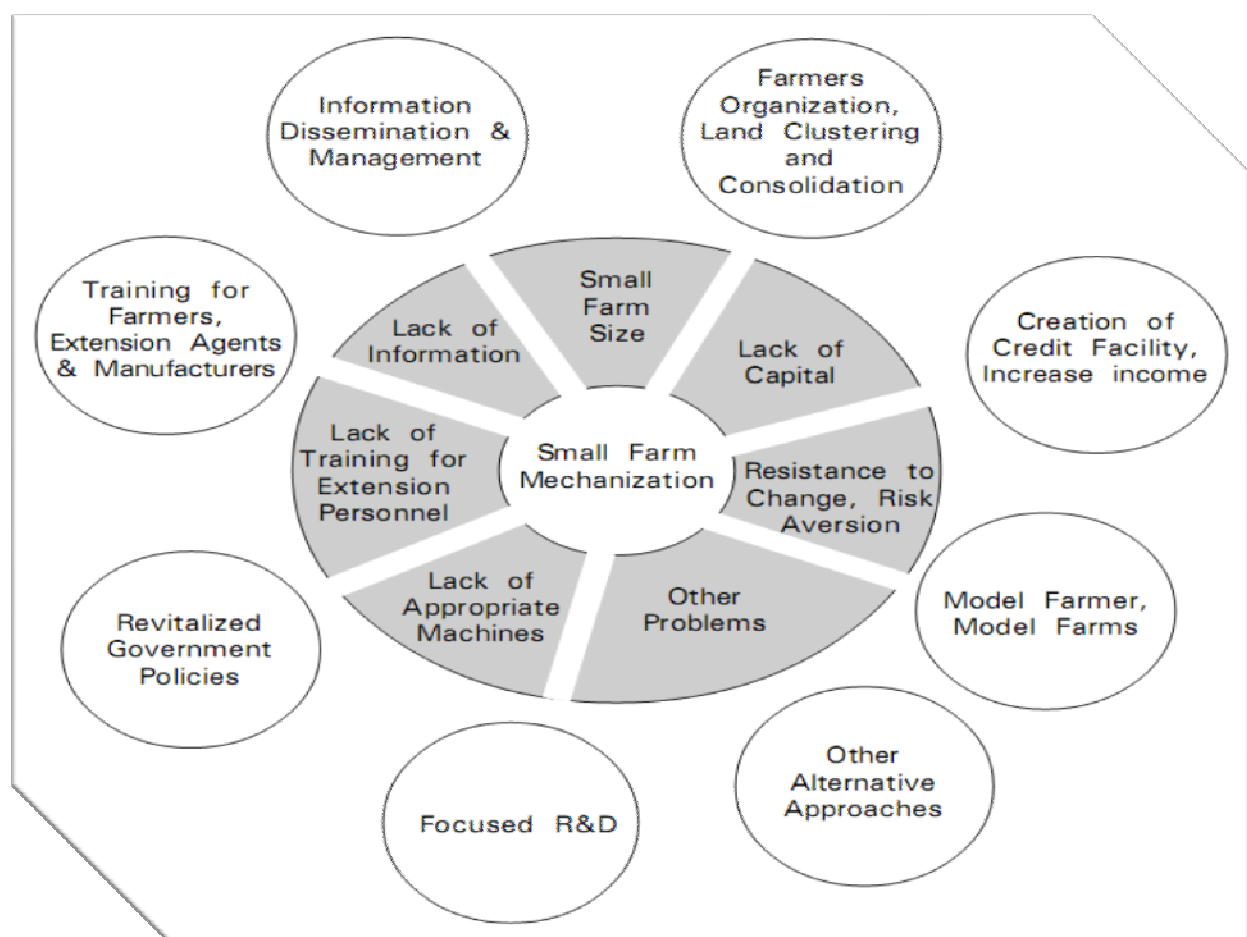
- Government focus is shifting towards mechanization of agriculture
- Lack of strong competition in the market
- China & India focus on Africa in order to further attainment of global power status-offers financial support in the form of credit.
- Available of large unused arable land
- Low level of mechanization
- High potential for tractor sales and earning revenue and contributions

Chapter Seven: Interventions

7. Interventions

There is no absolute formula for transferring mechanization technology, nor is there a tailored set of strategy to promote the adoption of agricultural machines. Variability of the conditions and the needs of the farmers limit the creation of a standard approach to disseminate mechanization technologies. In order to suggest appropriate strategies for small farm mechanization technologies, Paras and Amongo (2002), had suggested the following as a means to tackle constraints of agricultural mechanization.

Figure 10: recommendation for small farm mechanization



7.1. Demand creation

Importers, Manufacturer and dealer should be proactive in increasing the demand for agricultural machinery; they should not simply respond to demand but participate in its creation. This group is typically better educated than the majority of their potential farmers' clients and they have access to more source of information. As such, an effective awareness building and demand creating system would be vital to ensure that they can benefit a number of farmers. Currently, there is no significant promotion of mechanization to farmers. As such, by creating basic understanding of mechanization utilizing DA would ensure to reach a lot of farmers. Specifically by doing demonstration and trade fairs at local level...

- **Demonstration/field days:** for the purpose of promoting and awareness creating on the agricultural machineries among smallholder farmers, Importers/dealers should socialize the benefit of mechanized tractors to DAs and farmers. This involves conducting demonstration of agricultural machineries at field days and demonstration should occur regularly within the year to highlight a comprehensive set of services. Here, importers/dealers, repair and maintenance service providers and MFIs should also attend the field days to support farmers in accessing finance to pay for the service.
- **Agricultural Machinery trade fairs:** Besides creating awareness, it's a great opportunity for dealers and importers to establish local contact and to get teste of the local business climate and to get to know very closely with their client at district level. As such, we could facilitate to convince private sector to organize a fair of agricultural machinery at district level.

7.2. Establish/strengthen customer-hire services

Because of capacity and farm size of an individual smallholder farmers, buying tractor for personal use cannot be implemented in broader scale. To solve this, farmers capable of purchasing 2 WT should be convinced to own the machine and use them for customer hire services. Such tractor hire service providers should be promoted and established at kebele level to solve the above mismatch and to access tractor services for the vast market of smallholder farmers in the kebele and in surrounding. This tractor hire service providers could be model farmers, farmers group or cooperatives at kebele level.

7.3. Formation of strong farmer group

As mentioned earlier, most of the farmers have little capacity to own a costly machine. Even many of them cannot afford for simple manually operated threshing machines. But these can be eliminated by forming farmers groups. A group of farmers having their fragmented land in the kebele's can form bigger land by combining more than one plot together and can earn a remarkable financial benefits from using the machine. Beside this, farmers' group at kebele level

can be another option to bring them to hiring service business. In this case, the group can provide the services by themselves or they can hire an operator to provide the service on behalf of the group.

7.4. Facilitation of financial options for Agriculture machineries

As per the study in two of the districts, the package of financial institution service available to farmers is severely limited. Especially, credit for investment that pay back in the medium to long term is short supply. The MFI and credit union which generally have better outreach than the commercial banks in rural area, typically provide only short term credit. As such, finding a unique approach to generating access to financial services across the rural community must be investigate. Here I mentioned on approach for accessing loan for the farmers...

- **Machinery leasing**

The vast majority of farm machinery still acquired for cash or with conventional loan. Here, leasing offers a large degree of flexibility of payments and can be a popular choice. Leasing offers several advantage for farmers particularly constrained by lack of assets that can be used as collateral. Leasing overcome this constraint because it requires no collateral or less collateral than typically required by loan. Because leases often required lower down payment than the equity required for loans, they are more affordable for farmers that have limited access to borrow fund. As such, leasing can be done with three parties like Importer/manufactures, MFI's and Farmers. Here, the MFI's in the country are not yet exercising leasing as scheme. As such, it needs a lot of discussions and collaboration with MFI's in order to start leasing at least as pilot in our intervention areas.

- **Bulk purchase from manufacturer**

The MFI can purchase the tractors in bulk from manufacturers/ importers and sell it by loan to the farmers in cheaper price than the conventional outlet and helps also the MFI to ensure the loan is being used for intended purpose. In this case, if the farmers don't have a collateral, a group loan scheme can be applied for the farmers to take in group and all take the responsibility for loan. In this way if the farmer who has applied for the loan default on repayment the whole group become liable for his/her debts.

7.5. Establish strong network with District Agriculture bureau.

Currently the extension system does not conduct significant promotion of mechanization to farmers, either on small or medium and large mechanized. By integrating mechanization into overall extension package in the district area, awareness could be created alongside the traditional approach. This also create sufficient access to basic implements that farmers can easily purchase and install a basic understanding of mechanization as a concept for increasing productivity. Ideally, this would then lead to less obstacle when trying to introduce more agricultural technologies.

7.6. Train local operators

Here the advantage of training the local community in operator training may have multi-dimensional benefits to the local community. As such, we can train local unemployed youth TVET graduate, employees of garages and interested individuals at kebele level. This helps the mechanization and tractor information to disseminate in the kebele and indirectly influence the peoples need for such equipment's and services.

7.7. Strengthen or establish maintenance and repair services at kebele level

The maintenance and repair of hand tools and animal traction implements are mostly carried out at kebele level by the artisan. However, for tractors, the local artisan do not have a capability to perform this activity. As such, local TVET graduate at kebele level or skilled garage employees and local technicians should be empowered and trained to provide maintenance service in collaboration with the local institutes that engaged in such disciplines.

7.8. Encourage private sectors to have an agent for spare part shops at district level

Spare parts are vital for the upkeep and long term continued usage of mechanized implements. During period of high usage, it is vital that spare parts can be made readily accessible to where they are needed on short notice. Keeping sufficient stock of spare with high turnover is needed, especially at district level. As such, private sectors or Garages should be incentivized or liked with the importer to establish spare part shops at local level.

Chapter Eight: Conclusion

8. Conclusions

The level and appropriate choice of agricultural mechanization has direct effect on land and labor productivity; farm income; environment and the quality of life of small-scale farmers in the districts. Hence, basic farm mechanization required to provide to small –farm needs must be met, such as suitability of small farms, simple design and technology, versatility for use in different farm operations; affordability in terms of cost to farmers and most importantly, extension workers should also consider the issue of agricultural mechanization and the provision of extension services from the districts agriculture bureau and the private sectors are expected a lot to create demand and awareness about agricultural technologies using different methods of information dissemination activities such as multi-media, fairs, exhibits and demonstration needed to commercialize the mechanization sector.

Strengthening the supply of tractors is the other solution as poor quality of the service reported by farmers was the result of poor certification, standard and poor maintenance service provision for the machineries. The poor maintenance service provision or absence also leads to less number of functional tractors and this leads to high service provision price. Absence of competition in the market may be seen as one of the reasons for high price of tractor rental service. Moreover, high tractor rental price could also be the result of different factors such as, increase in the price of imported spare parts, fuel and lubricants price, unavailability of maintenance shops and garages locally, unskilled operator of the machinery and an economical farm size which consumed more fuel by turning here and there because of land fragmentation.

Availing credit for purchase of small tractors. It is proved that there is no credit facility for tractor service hiring or to buy tractor. Therefore, as tractorization promotes agricultural modernization which calls for market-led agriculture, credit facilities for purchase of small tractors and rental purpose should be given due attention. Beside this, training of local community in agricultural technologies, operation, repair and maintenance would also promote agricultural machineries and help to scale up and sustain the use of agricultural machinery in the areas and regions.