Investing in Agricultural Mechanization: A Means to Realize Crop Production Targets for the Growth and Transformation Plan (GTP) of Ethiopia

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Abstract

Ethiopian economy is dominated by the agriculture sector and its contribution is vital to the national growth domestic product (GDP). Accordingly, crop production, will remain the major source of growth in the growth and transformation plan (GTP) of Ethiopia. Increasing the productivity of the smallholder farmers through scaling up of best practices, expansion of irrigation, natural resource conservation, production of high value crops and encouraging the private sector are among the strategic approaches in the GTP of the country. In realizing this, improved agricultural mechanization technologies must be taken as one of the critical factors as they enhance production and productivity through timeliness, better quality of operations and precision in application of biological and chemical inputs. Furthermore, they can contribute to adaptation to climate variability and change and addressing social issues of gender and youth. Therefore, this paper discuses the need for investing in agricultural mechanization sector through formulating clear strategies that encourage the whole value chain and developing the capacity of stakeholders that guarantee the availability and sustained use of the technologies to meet the envisaged targets.

Key words: Agricultural mechanization, GTP of Ethiopia, smallholder farmers

Introduction

Being an agrarian country the agriculture sector plays an important role in the national economy, livelihood and socio-cultural system of Ethiopia. Contribution from the sector to the national GDP is 41.6% employing around 83% of the total population. It is also the main source of raw materials for agro-industries, food security and 85% foreign exchange earnings in the country (Adnew, 2006 and MoFED, 2010). Despite its being the most important economic sector, it is dominated by the smallholder and the pastoral livestock system. The smallholder agriculture accounts for over 95% of the cultivated land mainly in the highlands and medium altitude zones while the pastoral livestock production system prevails in most of the warmer lowland areas of the country (Adnew, 2006). Generally the production system is largely of subsistence orientation, low levels of external inputs, mainly rain fed with poor market integration. These have made the sector vulnerable to the vagaries of nature, particularly rainfall instability and drought leading to food insecurity. The share of commercial

farming sub-sector is still limited. Despite the large irrigable potential of the country the developed land so far is estimated between 150,000 and 250,000 hectares, which is less than five percent of the potential. (Werfring, 2004; Awulachew et al., 2005)

In curbing the aforementioned problems, the government of Ethiopia has developed and is implementing agricultural and rural development policies and strategies for rapid and sustainable development. The key direction of these policies and strategies is realization of agriculture-led and rural-centred development. Accordingly, in the last five years Plan for Accelerated and Sustained Development to End Poverty (PASDEP) (MoFED, 2010) period attention was given to the agriculture sector making it contribute significantly to the realization of the high and sustained economic growth recorded. In the current Growth and Transformation Plan (GTP) period also more is expected from the sector.

Agriculture mainly crop production, will remain one of the important sources of growth in the current GTP period of Ethiopia (MoFED, 2010). To attain the targets set in the plan period increasing the productivity of the smallholders through scaling up of best practices, expansion of irrigation with natural resource conservation production of high value crops, and encouraging the private sector are among the strategic approaches. These strategic directions mostly revolve around increased and efficient use of better chemical and biological inputs together with engineering based technologies. Agricultural mechanization technologies are among the important engineering inputs which create the favorable environment for the bio-chemical inputs to express their optimum potential even at times of worse climate. On top of this, agricultural mechanization technologies have their own value chain in creating off-farm jobs helping to attain the envisaged rural urban linkage.

Therefore, this paper attempts to describe the potential role of agricultural mechanization technologies, assess the current challenges in the sector and states the need to give better attention and investing more in the sector for the realization of the GTP and maintaining the momentum.

Potentials of agricultural mechanization technologies for meeting crop production targets of the GTP

The GTP agricultural development strategy is based on the experiences gained from the agricultural development program and lessons drawn from implementation of PASDEP (MoFED, 2010). According to the GTP, commercialization of smallholder farming will continue to be the major source of agricultural growth through production of marketable farm products for domestic and export markets. The average crop productivity planned to be achieved by 2014/15 will be 22 quintals per hectare from the existing 17 quintals per hectare (MoFED, 2010). Therefore, based on the targets set, this section of the paper tries to relate the potential role of relevant agricultural mechanization technologies fitting to the small holder farming system in attaining the targets.

Expansion of irrigation

Irrigation enables multiple cropping, significantly contributes for better adaptation to climate variability and

thereby ensures food security. The GTP will intensify the use of the country's water and natural resource via giving priority to expansion of small scale irrigation schemes and also giving attention to medium and large scale irrigation. Accordingly, by the end of the plan period, area under small scale irrigation will increase from 853 million hectare to 1850 million hectare (MoFED, 2010). Irrigation enables to produce at least twice per annum; it acts like a catalyst for mechanization requiring more farm power and implements with better efficiency (Verma, 2000; Li, 2004). Moreover, as it also involves use of different types of pumps selection and availing of the appropriate pumps, having proper operation skills and getting appropriate maintenance scheme are of prime importance.

New recommendations and new crops

Different recommendations being advised by the research system or those taken as packages require new or better agricultural mechanization technologies as they are hardly possible or not economical to execute them with the existing farm implements or bare hands of the farmers. For example row planting of different crops is a commendable practice that can enhance productivity through better management (Assefa et al., 1997; Heege and Billot, 1999). Row planting of maize has become a common practice while model farmers in wheat growing parts of Arsi are appreciating the results they witnessed (Personal observation). Though farmers appreciate row planting, most farmers complain and refrain from adopting it, as row planting by hand is a backbreaking exercise, time taking and it demands appropriate technology. Preliminary studies on teff row planting and transplanting showed encouraging yield increase (Bekabil et al., 2011) and a potential to revolutionize the crop management practices such as weeding and mechanical harvesting. However, because of the unique engineering properties (size, aerodynamic properties, flowability, etc) for some aspects in the production process, the crop requires suitable agricultural mechanization technologies different from the ones used for common crops grown in the rest of the world (Zewdu, 2007). Currently, this is a challenge to the engineers in the sector. So far, however, some encouraging results are being recorded by the Agricultural Mechanization Research Directorate of the Ethiopian Institute of Agricultural Research.

Ensuring food security is one of the major targets in the GTP period. Though much is not said on the GTP document, rice is relatively a new crop to Ethiopia and considered as the 'Millennium Crop' expected to contribute to food security (MoA, 2010). The recently developed national rice research and development strategy target that annual rice production is planned to increase from 500 thousand tons to 1.4 million tons and the area to be allocated will increase from 464 thousand hectares to 774 thousand hectares (MoA, 2010). Mentioning lack of efficient postharvest machinery as a cause for huge postharvest loss or hindering the adoption of the crop, the strategy emphasizes the need to invest on availing proper agricultural mechanization technologies ranging from land preparation all the way to postharvest areas.

Addressing problematic soils

Problematic soils in Ethiopia could be sorted as salt affected soil, acid soil,

vertisol and fragile or forest soil. Among these, the latter three (acid soil, vertisol and fragile or forest soil) are the challenges affecting the small holder farmer (Berhanu, 1985; Mesfin, 2007; Girmay et al., 2008). Accordingly, so far encouraging activities are being exercised in vertisol management in wet land of the country where water logging is a problem reducing the land productivity (Rutherford, 2009). In the GTP period the land to be drained using Broad Bed Maker (BBM) will increase from the existing 0.6 million ha to 3.0 million ha creating the need for increasing the existing number of BBM by at least five-fold. The BBM technology is one of the outputs of the research system which has undergone different improvements and still needs further improvement and customizing to specific areas as different complaints are reported by the users. Such improvement activities are being undertaken by the agricultural mechanization research centers of the national agricultural research system.

Application of lime is one of the recommendations in the management of acid soils for improving agricultural production and productivity in Ethiopia. The target set in the GTP indicates that lime treated land will reach 37850 ha. Applying the right amount with uniform distribution needs special equipment hence, the effort by the research system in availing such technology shall be strengthened. Forest soils are so fragile that the conventional land preparation will end-up with loss of the top soil eventually making the land less productive. Therefore, in order to minimize such loss practicing conservation tillage is being recommended (Girmay et al., 2008). Conservation tillage also needs different implement than the usual tools and equipments used by the farmers. For example, the rotary jab planter fits to this specific area and demonstration is being carried out around Assosa. Further attention shall also be given in the introduction and popularization of such types of technologies.

Production of market competent quality products and post-harvest loss reduction

Production of market competent quality crop starts from efficient land preparation and goes up to post harvest activities. This means in order to produce quality product we need to have a well prepared seed bed, proper placement of the seed and the chemical inputs (fertilizer, herbicide, insecticide, etc.), correct interculture, timely and efficient harvest and post harvest handling activities minimizing loss both in quality and quantity. Producing quality product and minimizing the post harvest loss in quality enables the farmers to get premium price in the market while reduction of loss in quantity will contribute much for the envisaged food security. Value addition through farm processing can reduce post harvest loss, increase rural employment opportunities and improves the nutritional status of the community. Improved post harvest technologies and practices like storage and value addition through processing will also increase the bargaining power of the farmer during the harvest season as well as during the bumper harvest year. However, all these advantages could hardly be realized using the existing agricultural mechanization technologies that the small holder farming system is using. Therefore, further promotion and

dissemination of the available improved technologies and bringing new technologies to the system through introduction from elsewhere after evaluation or development of the new ones is necessary.

In the GTP period, the improved seed supply is expected to increase from 0.56 million tons to 3.6 million tons. Like in the past PASDEP period the smallholder will remain vital source to attain the target. However, quality seed production requires proper management right from seed bed preparation all the way to cleaning, packing and storage. Such proper management could also be effectively exercised if proper agricultural mechanization technologies suitable to the small holder agriculture are availed.

Increasing of resilience to climate change

Apart from improving production and productivity to improve the living standards of the rural communities, copping better with the challenges of climate change is also emphasized in the GTP period. With regard to this agenda improved agricultural mechanization technologies can significantly contribute to efforts for mitigating the effects of climate variability and change through reducing vulnerability to climatic stresses. Mechanization technologies help to improve timeliness which enables the farmer to undertake farming activities with shorter time. This will make the farmer meet the production calendars already set or those to be set for emergency based on meteorological forecasts. Efficient moisture management by conserving the scarcely available water, safe drainage of the excess for reuse is attainable through the use of appropriate mechanization technologies. For example, using the *mofer* and *erf* attached mold board plough can give a lot of advantages over the traditional *Maresha* (Melesse, 2000). The *mofer* and *erf* attached mold board plough reduce the frequency of tillage by more than half reducing frequent exposure for evaporation, cuts the soil deeper encouraging infiltration and gives level field reducing the surface area exposed for evaporation as compared to the traditional *Maresha* which makes V-shaped furrows creating larger surface area per unit area of land.

On the other hand making tied ridges is a recommended practice for in-situ moisture conservation and being undertaken in moisture stress areas of the country (Kidane et. al, 2001). However, it is tiresome and time taking if done with the cultural *Maresha* or by hand. Excess moisture can be safely drained and harvested for irrigation and such activity is getting common in wet areas of Ethiopia having vertisol where water logging is a problem. Irrigation is one of the tools for making this nation to be resilient and here pumps of different capacity are critical inputs.

Variation in the ambient temperature, relative humidity and the gas dynamics in the air are among the anticipated changes in the era of climate change. Such variations could significantly aggravate the existing post-harvest losses at various levels. Therefore, introducing or promoting efficient storage and handling and processing facilities which fit to the small scale farmer is the other reason to be considered to make the small scale agriculture of the nation to cope better with the challenges of climate change.

Manufacturing

Micro and small-scale manufacturing enterprises (MSEs) are the foundation for the development of medium and large scale industries that can create job opportunities, help the expansion of urban development and render support for the development of the agriculture sector. Hence, the industrial sector development will give focus for the MSEs (MoFED, 2010). Involving these MSEs in manufacturing, dealing, custom hiring services and giving after sales services like parts supply and maintenance of the improved technologies will help to get the aforementioned advantages and will be the best solution for addressing the lack of improved technology multipliers being faced.

Other socio-economic benefits

Empowering women and youth and ensuring their benefits is one of the seven strategic pillars of the GTP (MoFED, 2010). In sub-Saharan African countries including Ethiopia, the role of women in agricultural activities is much significant and the labor and time they spend is huge (FAO, 2008). Women toil from dawn to dusk using backward traditional implements exposing them to drudgeries in a strenuous and time taking way. Almost all domestic postharvest activities are left only to women, and this can be shared by men through the use of improved technologies. For example, the present generation is a leaving witness that the introduction of modern mills made men to involve in grain milling activities. Therefore, availing improved technologies can contribute a lot in relieving them and can make them competent through giving time for various self upgrading activities like education, training and participation in the political, economic and social affairs. On top of this using these technologies they can economically liberated by engaging them into various processing and value addition businesses.

Major challenges in the sector

Agricultural Mechanization embraces the use of tools, implements and machines for agricultural activities starting from land development up to on-farm processing. It includes the manufacture, distribution, repair and maintenance, management and utilization and extends to how mechanization inputs are supplied to the end user in an efficient and effective manner (FAO, 1997). Therefore, farmers, researchers, extension experts, dealers, importers, standard and quality control sectors and financial institutions are among the important actors in agricultural mechanization. Agricultural mechanization strategy helps to create favorable institutional and market environment which leads the activity of the actors in the sector there by farmers and other end-users have the choice of farm power and equipment suited to their needs within a sustainable delivery and support.

Ethiopia has agricultural policies and strategies by which the sector is being governed. However, no clear strategy which leads the nation's agricultural mechanization undertakings has yet been developed. Similar problems are reported in other African countries and it is one of the major reasons put forward for the lack of effectiveness of these efforts of the sector (FAO, 2010). Serious

planning for sustainable development is yet not undertaken and this can be attributed to poor planning by government agencies and on-off, aid-in-kind efforts are dominating. The following are the small holder related major challenges, which emanate from the lack of clear strategy in the sector and need to be addressed in the GTP period.

Farm power

Using the worldwide data Giles (1967) showed the interaction and interdependence of farm power to other inputs (fertilizer, improved seeds, water and pesticide) for growth in agricultural productivity and overall production. Other studies also concluded that increase in agricultural production and productivity is directly correlated with the available farm power per hectare (Giles, 1975; FAO, 2006 and Verma, 2008).

Traditionally, draft animals (mainly oxen) have been the important source of farm power and essential components of crop production for the Ethiopian smallholder agriculture. Use of oxen for plowing dated back several millennia BC and studies indicate that Ethiopia's extensive association with animal traction is a typical of other sub-Saharan African countries (Goe, 1987). Furthermore, family labor is also a critical power source in the sector without which running the business is impossible.

The total area of all crops under private peasant holdings for the Meher Season of the year 2007/2008 was 14, 162, 667 ha (CSA, 2008). Assuming 85% of the economically active population (14-64 years of age) and all the oxen reported by CSA (2008) were engaged in agricultural activity of the season. Considering the amount of power generated per person and per oxen as 0.06 Hp and 0.3 Hp per person and per ox respectively (FAO, 1981), the power/land ratio which was available by then will be 0.28 Hp/ha. However, this power/land ratio was below the minimum requirement 0.5 Hp/ha (FAO, 1981). This indicates that despite the belief that enough labour is available, power shortage could be one of the probable factors contributing to the low productivity of the small holder farming system in Ethiopia.

Hence, looking for additional power source in additions to the ones existing on the farm such as donkeys, horses and camels, introducing mechanical power sources are mandatory. For example on average 4-5 years old camel in the central rift valley can generate up to 568 N force or 0.65 KW which is almost 1.5 times of an average sized ox (Workineh *et al*, 2007). Ploughing with camels is getting common in areas like Kebribeyah (Somali region) and Bofa (central rift valley) as the animal can withstand harsh environments (Yohannis *et.al,* 2007). Such practices should get attention and get widened in the areas where the animals are suitable. However, use of such equines and camel requires better research in determining the optimum power we get from the animals, adaptation or development of suitable and efficient harness, and matching implement. In introducing mechanical power sources, tractors with different horse power range, multifunctional platforms (machines with medium powered (8-10 hp) engine driving various equipments) and use of the electric power, which is being availed through the rural electrification program for different activities like pumping water, threshing, dehulling, milling,

etc…, should be considered. This could be made practical through custom hiring or rental basis or collective ownership creating job opportunity for dealers, manufacturers, mechanics, etc and ensures gradual replacement of labor to release to the non-agriculture sector. In line with this, a study made on 160 house hold samples in Oromia proved the profitability of using hired tractors for wheat and teff production (Tamirat, 2011).

Low use of improved mechanization technologies

The smallholder agriculture in Ethiopian is characterized by the use of traditional and backward farm implements and practices. The entire field operation is carried out using century old tillage implement called *Maresha*, mainly with power from the oxen. Other operations in crop production are performed almost with bare hands or very rudimentary tools and implements. As a result, labor productivity is very low. Several studies have shown that there is a great imbalance between the labor input and the output obtained in all agricultural production works (EARO, 2001). This has contributed much to the chronic shortage of food being observed in the farming population. In order to curb this, efforts made and attention given by the research and extension systems and various stakeholders like NGO's were not to the level of bringing satisfactory and visible result. The country lacks appropriate and efficient technology multiplication and popularization/ promotion system.

The improved or introduced technologies have significant role in improving labor and land productivity, timeliness, reduction of losses at various levels and producing quality product for marketing and industry. However, except for very few of them, the popularization done on them is minimum. Regarding the technologies some are limited to certain crops while some need further improvements. Table 1 shows types of traditional implements being used and available improved or introduced technologies for different crop production operations.

Table 1. Types of mechanization observed in small holder Ethiopian farms

Field Operation	Technology Type	
	Traditional	Improved/ Introduced
Primary and secondary tillage	Hoe, Dengora, *Maresha*,	MB Plough, Tenkara Kind, Hired Tractor
Land forming	Hand, Hakafa and *Maresha*	BBM , Tie-Ridger
Planting (broadcasting or row planting)	Manual	Row Planters
Interculture and Weeding	Manual, Hoe, *Maresha* (known as Shilshalo),	Wheel Hoe Weeder, Winged Plough
Harvesting	Sickle, Machete, Mencha	Hired Combine Harvesters
Threshing	Beating By Sticks, Trampling by animals	Engine Operated Threshers And Shellers, Hired Combine Harvesters
Transportation	Human, Pack Animals, Wheel Barrow, Animal Drown Sledges	Improved Carts, Vehicles
Storage	Gottera, Dibignit, Underground Pit	Improved Gottera, Evaporative Cooled Storages Structures
Milling	Manual Cultural Mills	Motorized Mills

Lack of capacity

Research and higher education

Professional level training in the field of agricultural mechanization limited to Hawassa University. Adama University has started giving both under graduate and graduate level (M.Sc. level) training. However, the number of graduates from each university is limited and all the universities have shortage of staff and their facilities are not to the level of the need of the trainings. Most training programs, in their courses of agricultural mechanization, emphasize on modern agricultural machines and tend to ignore or give little attention to traditional implements making the new graduates to be strangers to traditional agricultural tools and implements and have to start building up their knowledge from scratch (EARO, 2001). Therefore, lack of attention has resulted in a severe shortage of well trained manpower in the sector both for the research and development.

On top of the workshop facilities for manufacturing prototypes research in agricultural mechanization requires laboratory facilities. The laboratory equipments are critical in order to get reasonable data which will enable the research system to deliver better performing technologies with shorter time. However, almost all of the country's agricultural mechanization research centers suffer from shortage of laboratory facilities. Data acquisition in the sector also needs development of instrument/systems for measurement and recording of various parameters and this requires special skill.

Extension

Except for very few implements like the broad bed maker (BBM) attention given to the sector by the extension system of the country is so far minimal. Curriculums of the ATVETs and FTCs do not include agricultural mechanization, hence, DAs and other development workers usually fail to understand easily most of the technologies being pushed by the research system.

Technology multiplication/ manufacturing

Artisans in Ethiopia usually inherit the skill from their families and they use the traditional blacksmith facilities. However, most of the improved technologies require far better workshop facility and trained manpower. This could be one of the reasons contributing to the lack of improved agricultural technology multipliers becoming to be one of the bottlenecks of the dissemination improved farm implements. In order to curb this, training entrepreneurs with modest facility and availing working drawings and manufacturing guidelines for them has recently been taken as a solution and this is creating a win-win situation. So far, a number of trainings have been given and by the end of the year 2010 the Agricultural Mechanization Research Directorates of the national agricultural research system has trained around 70 entrepreneurs selected from the whole parts of the country.

The Ethiopian government is expanding the Technical and Vocational Education and Training (TVET) significantly since 2000/01 with major objective of meeting the middle level human resource demand of the industry (including SME), service and the commercial agriculture sectors (MoE, 2006). The potential of the graduates from the manufacturing and mechanical sector TVETs on manufacturing and assembly of agricultural machinery is considerable.

However, emphasis by both the agriculture and the non-agriculture curricula of the TVETs on operation and maintenance of agricultural machinery is not strong.

Lack of standard and quality control

Standards help to keep product availed by a manufacturer or a supplier function the expected level with an optimum input and fulfills the safety requirement set. Quality control is a means to check weather that product is up to the national standard set and also a tool to keep multiplied technologies to be as per the design and recommendation of the research system. However, such important instruments are missing in the Ethiopian Agricultural Mechanization sector. Because of the lack of standard and quality control lots of complains are heard on BBMs and treadle pumps manufactured and distributed in different part of the country. Unless immediate actions are taken farmers will resist to accept these technologies and similar other technologies.

Lack of information

Unlike the other inputs information available on agricultural mechanization technologies is limited. The data base indicating the real picture is not yet established. This could be attributed to the lack of attention given so far and the limited capacity available at all level.

Conclusion and Recommendations

Though improved agricultural mechanization technologies which suit the smallholder agriculture are very important in enhancing the production and productivity of the farming systems, the attention given to the area so far is unsatisfactory. Hence, giving better emphasis and investing in the sector is an unconditional choice to realize the crop production targets of the GTP. In addition, favorable ground can be created to keep the growth momentum of the agriculture sector while releasing human power to the industry sector.

Up on investing in the sector, priority must be given for formulating a clear strategy that leads the country's agricultural mechanization development. In doing so, analysis of the existing situation and developing a base line and setting the targets that can help attain the future needs are among the important tasks. Based on the strategies set, capacity building both in terms of skilled human power and facilities for research and development should be considered. Clear technology transfer/dissemination mechanism should be developed to make the technologies accessible to the farmer and involve different entrepreneurs in the value chain of the sector.

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