

Agricultural Mechanization in Ethiopian: Experience, Status and Prospects

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Abstract

Agricultural Mechanization deals with the use of any mechanical aid in agricultural production. These mechanical aids could be simple hand tools, animal drawn implements or sophisticated mechanically powered agricultural machines. The source of energy ranges from humans, animals to engine or electrical power. Generally these are categorized as hand tool,, animal and mechanically powered technology. The productivity of each level depends on the power source. Humans being inefficient one can hardly cultivate a hectare of land per season, where as animal powered technology is of no use beyond three hectares where as mechanical powered technology is good enough to cultivate a minimum of 40 hectares even in sub moist zones where the window of operation time does not exceed 15 days. The three levels of mechanization have existed in this country for many years now. During Imperial Ethiopia, there were big farms operating as share companies, where mechanically powered technologies were used in areas like Dubti, which were highly productive and produced competitive product in the then world market. During the time of the Derg and now most of the big farms are not producing to the level of the national average. Today you hear in the news that entrepreneurs have cleared the land, but not have started production yet. The mode of land clearing was not systematic and did not take precaution in terms environmental and social safe guards. It is not only the level of mechanization, but the discipline commitment in the mode of production that guarantees the sustainable production and productivity of the land to meet today's need and the requirement of tomorrow's generation. Land is a limited resource, besides the competition for land from the other economic sectors is paramount, despite the increasing population and the number of mouths to feed. Under these circumstances it is only a knowledge based agricultural mechanization system, where precision and efficiency are the pillars that will operate under this paradox of feeding increasing population in a situation of dwindling resource base.

Introduction

In Ethiopia land preparation usually starts in April, which is after a long dry season. Maize and Sorghum are planted in April and the field operation continues till small cereals like wheat and tef are planted, which is usually in June July. During this extended period, the work load is high, despite the feed shortage. This obviously affects the performance of draft animals. The influence of the yoke on power output and health is significant, despite that in Ethiopia the same equipment *mofer and kenber* is used across the country

Ethiopia is an Agricultural country predominantly relying on draught animal power. Hand tools are mainly used in some South and South Western part of the country, where most are infested by tsetse fly making it hard for cattle to survive. In some parts of these areas like Assosa and Gambella hoe culture and shifting cultivation dominate. This was the case till the introduction of the settlement scheme. Gradually draught animal based agriculture was introduced by the settlers into these areas. In the lowlands of Afar and Somalia, which are predominantly pastoral areas, farming was introduced with mechanical power technology especially with the establishment of the big cotton farms.

Generally we can see three distinct eras in the Ethiopian Agricultural Mechanization History starting from the mid 1960s to the present.

Agricultural Mechanization in the 1960s

Draught animal power and hand tool based agricultural mechanization have existed in this country ever since time immemorial. The draught animal power based technology is more of the highland culture, where hoe culture was dominant in the land abundant fertile land of the South and Southern part of the country.

Settlement schemes, tractor hiring service and large scale operations were exhibited in the mechanical powered mechanization category at that time. The Awash Valley Authority, Middle Awash Settlement, Tendaho Plantation Share Company and Setit Humera were some examples .

The Middle Awash Settlement

The Middle Awash Settlement Scheme was based on technology of growing irrigated cotton. The entire area consisted of 12000 hectares on the Amibara Plaines. The scheme was meant to introduce settlers gradually to the complexities of mechanical power agricultural production to large scale cotton production.

The Middle Awash Settlement scheme objective was mainly technical with concomitant sociological grounds. It was based on the technology of growing irrigated cotton. The aim to grow cotton on land formerly grazed by the herds of the pastoralists was intended to encourage a number of these people to settle and become sedentary farmers (Kline et al. 1969)

Tendaho Plantation Share Company

The Tendaho Plantations Share Company was established with a share of 2, 472,000 dollars as a joint venture between agencies of the Imperial Ethiopian Government, Ethiopian share holders and Mitchell Cotts and Company. The total amount invested was 5,840,000 about 10000 hectares at Dubti, Dete Baheri and Logghia. Operation started on a pilot scheme in 1961. In 1962/3 1100 hectares were planted at Dubte, which later increased to 5000 hectares all together in the three farms (Kline et al 1969). The company had an out growers scheme, which in the 1966/67 contributed approximately 30,000 quintals of raw cotton. Cotton plantations of such dimension involve a complex system of management. Both administration and management must be intensive and efficient to avoid large losses. Tendaho plantation demonstrated capabilities of intensive and efficient management and was one of the successful private commercial enterprises at that time.

The Tendaho farm assigned one 55-60 hp tractor for each 100 hectare under cultivation during the initial development period till it reached 4000 hectares. After reaching 5000 hectares the management was able to increase the cultivated area per tractor from 150 to 160 hectares through greater field efficiency, better operators, more level fields, less breakage and down times. The Tendaho plantation followed a strict maintenance

schedule, where each operator was solely responsible for his tractor, cleaning and doing the daily maintenance every day after work, changing filters every 150 hours. More over every Saturday at 1600 hours, each tractor was brought to the machinery pool, bolts tightened and weekly lubrication was strictly followed (Kline, et al 1969). No wonder that the Tendaho farm was very efficient and at least 50% of this increase in efficiency was attributed to good handling of machinery, effected through training and experience among operators who accepted greater responsibility for their machinery.

Humera

The other important area was Humera in the northwest of Ethiopia to the Sudanese borders between Setit and Angareb river covering 3500-4000 square kilometers . It was primarily developed by private enterprises with assistance of modern engine powered equipment although a large number of OX farmers, with small farms of six to eight hectares have settled earlier. The area was a rapidly growing area in 1966 with 158 farmers using 229 tractors. At that time it was estimated that there were more than 400 tractors with 19 different models from 12 manufacturers in 8 different countries. Land was assigned to individuals in blocks of 400-1000 hectares. A 70 year lease was granted for about 7000 hectares. Some 60000 migrant workers come to the area annually for weeding and harvesting. Expansion has been rapid without organized planning and infrastructure in administration, health and communication. Shortage also existed in labour, credit, market, storage and agricultural services (Kline et al 1969).

Agricultural Mechanization of the Derge Era

As in the previous period, the hand tool and draught animal power mechanization has extended throughout this period in the highlands and the South Western part of the country. Following the land proclamation of 1975 and acknowledging the importance of large scale mechanization, the *Derg* established big mechanized (third category) farms then called "state farms", by confiscating private farms and establishing new ones.

A field study was conducted in the years 1996 and 1997 in some state farms with the objectives of understanding their mechanization schemes and derive lessons that help in better planning of future mechanization programs. An in depth discussion was held with maintenance personnel and machine operators during the field visits. Maintenance schemes and machinery history cards were also studied during the visits.

The study focused mainly on five State Farms of differing agro-ecology, two research centers, two machinery hiring organizations and machinery importers as indicated below:

- The Agricultural Equipment And Technical Service
- Enterprise
- The Awassa State Farm
- The Adele State Farm
- The Dedesa State Farm
- Upper Birr State Farm
- The Zeway Horticultural Farm

The Agricultural Equipment and Technical Service enterprise (AESTCE), among its many objectives was mainly established for the purchase and distribution of agricultural and construction equipment,

Initially about 448 farms of different size with a total of 131,000 hectares came under the State farms' management. Then it was reduced to 238,300 hectares in 1990 because of difficulty in management. The total area towards the end of the *Derge* regime was about 200,000 hectares, out of which about 47,000 hectares were irrigated. Most of these farms were established because of the pressing need for increased food crop production. This was done within a short span of time and in most of the farms let alone a detailed planning, even preliminary land use, soil and fertility studies were not conducted. No suitability study and maintenance requirements were analyzed when different tractors and implements were imported into the country.

The Ministry of State Farms through the Agricultural Equipment and Technical Service corporation was responsible for importing, distributing and after sales maintenance of the agricultural machinery and implements to the different state farms.

Not much success story is told about the State Farms, because of a number of reasons among which the steps taken in selection, procurement and management of machinery and equipment were major problems. Though most farms did not have much success story, no doubt that they have served in filling the gap in agricultural production, and created job opportunities for many people.

The *Derg* established the farms within a short span of time mainly with ZT, IMT tractors and E512 combines imported from the former East European countries and locally assembled NTAP tractors. High oil leakage and down time was recorded on the ZT tractors in all the state farms, despite their superior power attributed to their heavier weight and engine displacement. Higher failure on the ZT was recorded at Adele compared to the other farms. The NTAP tractors were mainly used for transport purposes in most of the farms; a higher frequency of failure was recorded in most of the farms on the NTAP tractors, except at Zewaye. where they were relatively successful. Newly introduced Landini tractors received favorable response both at Awassa and Birr, except wheel rim failure reported at Birr. The E512 combines were favoured despite the oil leakage problem compared to Zemaye in most of the state farms. Nardi plough and DLA harrows had good acceptance in most of the farms visited. Most of the farms did not keep maintenance records and machinery history cards. Their drivers were trained on the job and even the mechanics did not have any formal training (Friew and Shilema 1998).

Research and Extension

There were Research and Extension programs working on the development of small agricultural implements and stationary small engine operated equipment established under the Ethiopian Institute of Agricultural Research. There was also a strong Rural

Technology Promotion program operated by the Ministry of Agriculture.

The research program was established at Mekele mainly dealing with irrigation and small implements and later on strengthened and was established at Nazareth. The unit was a division in the Agricultural Engineering Department mainly comprising of Soil and Water, Farm Implements and Food Science. The Farm Implements division was responsible for the development of hand tools, animal drawn and small engine powered equipment like threshing and shelling machines. The center was also mandated to test all sorts of agricultural equipment locally manufactured and imported implements. The center started work on a Chain and Washer Pump and *Enset* Processing projects and later included projects on land preparation, crop establishment harvesting and threshing technologies. At this time ploughs, threshers, donkey carts tie-ridgers were developed and popularized among the user community. Along with the Research and Development works testing and evaluation were handled by this sector. One important work handled by the center was the evaluation of 22 tractor drawn Bulgarian implements, comprising of ploughs, harrows, trailers, planters cultivators including ridgers and trailers. At that time there was a plan to establish an agricultural implements factory and these were the kind of implements to be fabricated. The Institute tested the implements at Adele and Awassa and delivered the report to the government, where the implements were found faulty and substandard both at the controlled test on station and durability test conducted on the field at the places indicated above. The Bulgarians and the Government finally accepted the report and deterred from establishing the factory right away.

Rural Technology Centers were also established by the Ministry of Agriculture in the different Administrative zones of the country with their head quarter in Addis Ababa. The Ministry established 8 rural technology centers at Kombolcha, Assela, Sodo, Mekele, Bako, Jimma, Baherdar, Harar and Tigray. These centers were established with the objective of promoting rural development through increasing agricultural productivity, rural energy and promoting rural small scale industries. Besides, 25 rural technology hiring stations and 170 farmers' technical service stations were established at service cooperatives in the country. The rural technology centers multiplied proven hand tools, animal drawn ploughs, carts, threshers and shellers and beehives. Besides farmers were trained on the repair and maintenance of agricultural equipment and production of house hold goods. They multiplied, demonstrated and distributed implements to the farmers in their respective areas of establishment. Among the implements promoted by the rural technology centers, Maize Shellers, with a shelling capacity of 40-50 qts/hr, transport carts were highly favoured and are still operational in most parts of the country. Farmers reported some income of 5000-7000 birr in three months by hiring the maize sheller around Kombolcha, while some farmers around Bako earned 10000 birr during the same period (Kebede 1998). Centers like Bako, Assela, Sodo were established prior to the *Derg* era by the CADU and WADU and some missionary organization.

At this time higher learning Institutes, like Jimma, Ambo, Alemaya and Awassa Agricultural Colleges were training students in Agricultural Engineering, who were

meant to be instrumental in handling the field and workshops works at the different private and later on state farms. These institutes were not enough to deliver the required human power both in quality and quantity to handle the required personnel at the different farms. Most of the works in the state farms including the sugar estates were supported by students who were trained in Eastern Europe especially Russia and Eastern Germany.

The Present Era

Currently most of the organizations have continued to work on Agricultural Mechanization schemes in one way or another. The small farmers have continued their operation in their size dwindling farms, though the state farms are deemphasized now, big private farms have started to emerge, Most Rural Technology Promotion Centers are now transformed to Regional Mechanization Research Centers, but still we do not see much Agricultural mechanization training institutes.

Currently, a country wide study on Agricultural Mechanization, is being conducted by the Melkassa Agricultural Mechanization Research program, where the intermediate results are relevant and important to this workshop. The frame work of this study is based on the main actors of mechanization and concentrates in the main agroecology zones the country.. The country has diverse agro-ecology and the potential and constraints of these different zones have bearings on the Mechanization level and system to be followed in meeting the agricultural development objective of the country.

Agricultural Mechanization Actors

The main actors in the Agricultural Mechanization System are the farmers, dealers, manufacturers and supporting institutes and organizations.

Farmers

Because of the land size a good majority of farmer employ the lower level of mechanization which is based on draught animal power. The country has diverse agro ecology ranging from arid to semiarid, sub moist moist to humid and per humid zone. In the dry areas rain fed agriculture is unthinkable, in the sub moist zone, there is a small window of operation period especially for land preparation and planting. Moisture is also critical during the seedling and flowering period. In these zones moisture conservation technologies like tied ridges have been employed for in situ moisture conservation. This technology is adopted by most farmers and has rescued the crop from total failure in most sub moist zones. In areas where the onset is late or limited to few days farmers were not able to prepare the land and sow the crop in time and are not able to use the whole crop growing period. In such zones, crop failures are recorded most of the time and farmers are not able to handle more than a hectare during the growing period in these zones, according to the study conducted at Melkassa, as most farmers handle their farming and planting operations in June, they have less than eleven days to complete the whole operations. Especially with the small cereals as the land has to be well pulverized, they cannot handle more than a hectare within these period or do a substandard work, like planting late, which results in

depressed yield as they will not be able to use the whole growing period. In this zone the land preparation and planting should be conducted in the shortest possible time. This is attainable if they are able to handle the work with a higher level of mechanization (Table 1). If they go for higher level for land preparation and settle with their traditional practice for the other operations they will have three times the advantage and if they choose the mechanical power for both the operations they will have a 10 fold advantage with that window of operation time.

Table 1. Operation window in sub moist zone and mechanization options

Mech level	Operation window	Time taken /ha	Operation index (a/b)	Remark
Animate (landprep+crop)	11 days (88 hrs)	56 hrs	88/56=1.57	Landprep+pl (4+3)days@ 1000birr/ha using oxen
Inanimate	11 days (88)	27	88/27=3.25	Landprep+plant (tractor+oxen)
Land preparation		3hrs	88/3=29.3	
Land prep+pt time as related to growing period (2160)hrs		2160/27=	80	
planting		24hrs	85/24=3.54	
Inanimate tandem	11 days (88)	3	88/3=29.33	Operation in tandem (both tractors, ploughing+planting) @ 1600birr/ha

In the moist and other non moisture stress areas the problems is water logging . The vertisol areas in these sectors have the potential of giving three crops per year. Farmers in these areas used to plant wheat late in the season, but with the introduction of the BBM technology, farmers are able to plant early and grow chickpea immediately as observed in Ginchii.

Commercial Farms

A significant number of farms are now operational in the country. These farms range in size from 100 hectares to 100,000 hectares (Karaturi). Some of them operate in the former state farms, which are currently privatized, some are new developments. The new farms are mainly in Benishangul, SNNP and Gambella region. The former ones like Birr, Ayehu are also operational. Most are rain fed and some are irrigated. More than 300,000 hectares are operational using tractors and implements. They grow mainly cereals, pulses and oil seeds. There are also cotton, coffee and tea plantations. It is hard to say that they are fully operational. On most farms the study team visited, the mechanization level is still less than 0.5 hp/ha. Currently over 400,000 hectares of land is leased to foreigners, the Diaspora and national investors in the different parts of the country. Though we do not have a power disaggregated data, based on the general information

available, the mechanization level does not exceed 0.5, which has a bearing on the productivity of the agricultural system. From the study, the recorded yield data indicate that cotton production in most farms is in the range of 20-30 q/hectare. Maize yield varies between 40 and 50 q/hectare and oilseed production especially sesame is below 4 q/hectare. Yields also vary within one agroecology. Most farms do not have well trained farm managers except one or two farms. The mechanics are not trained, but have acquired skill through long years of experience. Periodic maintenance and management scheme is more traditional.

Dealers and Manufacturers

There are big and small machinery dealers operating in the country who have specialized in the delivery of brand tractors and Agricultural machinery. Ries Engineering, Moenco, Kaleb, Hagbes, Gedeb and Case are some of the important companies. Massey Ferguson, Landini, Case, SAME, John Deere and Case are some of the important tractor brands which are imported by the above companies. The former Nazareth tractor factory, now called the Adama Agricultural Machinery Industry operating under EFDRE Metals and Engineering Corporation (METEC) is the other important enterprise which imports and assembles tractors like Bailarus and other Chinese brands ranging from walking tractors of 8 hp to four wheel tractors in the 300hp range. It is estimated about 5090 tractors were operational in the country up to 2010.

The number of tractors imported into the country according to the data from the Ethiopian Custom and Revenue Authority now stands around 12 231. This data does not specify the horse power and at times lumps the accessories as tractors. Though the data does not specify the horse power of the tractors, they have categorized them as pedestrian, track laying and simply as tractors. Along with this, they have indicated the net weight and the number of units imported in each category. Based on this information, effort was made to assess the number of tractors based on the brand names, unit weight of the consignment. Thus this is a derived information from the raw data produced by ECRA. This does not mean that all are in the field as a substantial number imported by METECH are still lying at METECH compound in Nazareth, where the majority are the pedestrian type tractors. If we assume that 50% of these number is out in the field and 2010 about 11000 tractors were currently operational.

The Agricultural Investment Directorate

The Ministry of Agriculture has established the Agricultural Investment Support Directorate (AISD) in order to support development in the Agricultural Investment sector. The specific objectives of the directorate are:

- To identify and delineate potential agricultural investment areas
- Transfer agricultural investment land to investors
- Provide comprehensive support

The AISD in collaboration with the Benishangul Gumuz, SNNP and Afar Regional states has delineated agricultural investment areas in the respective regions. In Benishangul, 161055, 327, 206, 131882 and 71841 hectares are delineated in Dangur, Guba, Wombera and Assosa weredas respectively; In Gambella, 132490, 385049, 101253, 55784, 57400, 34540 and 62683 hectares are allotted in Akobo, Dima, Itang, Pigewedo, Shentawa and Metar weredas respectively. In the SNNP at Dasenech, Gangatom, Hamar and Southern Ari, 76409, 71473, 16292 and 16451 hectares respectively are delineated.

Where as in Afar Region, 33694, 131014, 35896, 88337, 14124, 23168, 14484, 55003 and 13958 hectares are designated in Assayta, Dubti, Afambo, Mille, Gewane, Amibara, Awash Fentale, Dalifage and Dewe weredas respectively (MoARD 2009). According to the Ethiopian Agricultural Portal to date about 416,803 hectares are transferred to different investors. From unofficial reports, it does not mean that all areas transferred so far are put into production. Some are being cleared and some have started to grow crops on some parts of the land acquired, some could even be abandoned.

Most of these zones have been forest lands and the SNNP and Benishangul zones exhibit some steep slopes, which need serious consideration in land clearing, cultivation and crop selection to maintain sustainable ecology and minimize erosion as well.

The Research Extension Sectors

During the time of the *Derg*, there was only one Agricultural Mechanization Research Center, operating under the Ethiopian Institute of Agricultural Research (EIAR), but now Regional Agricultural Mechanization Research Centers are established in Oromya, Amhara, Tigray Afar and Somali. The ones in Oromya, Amhara and Tigray are strong and have delivered a number of technologies which are distributed to farmers in their mandate areas.

The Federal Agricultural Mechanization Research Center

The Federal Agricultural Mechanization Research Center, which started as a project and strengthened through a UNDP project signed in July 1984 has been working on development of hand tools, animal drawn and mechanical powered pre-harvest and post harvest agricultural implements.. Moldboard plough, planters, weeders, harvesters, storage structures, donkey carts, potato digger multi crop threshers, groundnut sheller and *Enset* processing devices are some of the implements developed by the center (Agricultural Mechanization Research Process 2009). Some of these implements like the moldboard plough, tie-ridger and carts are widely used by the farmers. Currently the Center is working on tef and wheat row planters. Some favorable response is received on these implements from farmers and manufacturers are also trained on the manufacturing of these equipment. These implements are thought to increase both labour and crop productivity.

Oromia Agricultural Research Institute, Agricultural Mechanization Process

In Oromya, there are four Agricultural Mechanization Centers (Assela, Bako, Jimma, Fedis). In all the centers there are two divisions named as pre harvest and harvest and post harvest divisions. Bako started as a technical school in 1968 and the others were Rural Technology Promotion centers, doing mainly demonstration and multiplication of agricultural implements and machinery and implements. They were integrated to the Oromya Agricultural Research Institute (OARI) as rural technology research centers in 1994 E.C now called Mechanization Research Centers. The centers are responsible for undertaking research in Agricultural machinery and implements, Small scale industry, Small-scale energy and Food and feed processing technology. They also provide training to farmers, manufacturers, dealers; offer hiring service and are also involved in multiplication of technology. Some of the implements developed by these groups include: ARDU Moldboard plough (625-800m²/hr), Single donkey plough, winged plough, and wheat row planter, water lifting technologies (treadle pump, rope and washer pump).

Hand sheller (100kg/hr) and ground nut lifter, manual operated maize sheller, Engine and p.t.o operated shellers (0.5-0.6 ton/hr), produce 30 pcs per year, Assela wheat and barley thresher (0.3-0.6 ton/hr), ground nut decorticator, winnowers transport and storage technologies, *Enset* decorticators, milk churner, bee hives, feed choppers, grass balers, different type of fuel saving stoves, biogas plants, water power flour mill, solar cooker civet cage trap, poultry house as well. The group has done some work on evaluation of votex thresher on black cumin (Lelliso Eddoshe and Birhanu Atomsa 2007) and has modified the IAR model hand maize sheller with a smaller weight fly wheel, the weight concentrating on the outer rim of the fly wheel (Zelalem Biru 2007) .

The Amhara Agricultural Mechanization Food Science Research Directorate

The Amhara Regional State Agricultural Mechanization and Food Science Research Center started as Bahir Dar Rural Technology promotion Center in 1985 with the responsibility of multiplying and popularizing agricultural implements around the North and western part of the country. After 1996 the center has been reorganized as a mechanization research, technology multiplication, production and maintenance team. In 1999 it was organized to conduct full fledged research with the responsibility of generating, selecting, developing and adopting and promoting agricultural mechanization technologies. Later in 2007/08 the Food Science research has been included and now operates as the Bahir Dar Agricultural Mechanization and Food Science Research Center. The center is mandated to do R and D works on agricultural mechanization and processing constraints with the responsibility of developing, testing and introducing effective appropriate technologies suited to the region.

Some of the technologies generated by the Center

Modern bee hives, treadle pumps, drainage and moisture conservation technologies are being widely used in the region. Improved plow, weeder, planter, harnessing

technologies are already in use. Crop threshers, sheller, grain storage, potato storage, carts, wheel barrow, hay press, churns are also availed. Poultry houses, hatchers, feed processing, feeding equipment, milking equipment are addressed for the livestock sector

Milling size reduction, preservation and shelf life enhancement technology, churns , small scale possessing technologies for perishable products, improvement of traditional food, product safety and quality are addressed in the processing and food science category. The center also renders technical back stopping

Tigray Regional State

The Tigray Rural technology promotion centers were established during the *Derg* era Like the other enters, this one was also responsible for promotion of implements, rural energy and rural industry technologies.. There was also an attempt to establish an implements research center at Mekele in 1967 by FAO, but could not materialize because of the then situation. After the fall of the *Derg*, Mekele Rural Technology Center was established in 1995. It was meant to demonstrate, multiply and popularize technologies developed elsewhere. After 2004 this department was established as an agricultural mechanization research center. The center since its establishment has been focusing on pre-harvest, post harvest, agro processing, biomass energy and fuel saving technologies, alternative sources of energy and water lifting technologies. Since its establishment the center has been promoting similar technologies to the Region like the other regional research centers.

Ethio-German Agricultural Further training center

This is a project established with the support of the German Government at Kulumsa Agricultural Research Center. The project objective is to train technicians and new farmers on the use of new farm business concept and on the use of modern Agricultural Machinery. Its key activities include

- Practical and theoretical training to farm managers, skilled labourers, marketed oriented farmers in sustainable agricultural production system. Also the training deals with the use, maintenance and repair of agricultural machinery.
- Field demonstration for
- Deployment of mobile training unit planned in other potential region

The first machinery were handed over and deployed in May 2012. At this time precision planters were demonstrated out in the field and some of the equipment were tested on tef as well.

Higher Learning Institutes

Haramya University was the pioneer in training people in the field of Agricultural Engineering, where farm power and machinery courses were given as core courses This was augmented with Agricultural Mechanization courses given by Hawassa University. But the Agricultural Engineering program was deemphasized in Haramya and was a gap for some years. It was only Hawassa which was offering Agricultural Mechanization

courses for the whole country till recently. Currently Adama University, Ambo and Haramya have started to offer the Agricultural Mechanization Courses. Adama has its first graduates and Ambo is expected soon. Haramya restarted to reoffer the course in 2007 after some long years of gap. Ambo is expecting its first graduates soon. Despite their long years of experience in teaching agricultural engineering, the courses are still classical and the mode of instruction has not been updated in most of these institutes. You do not find many senior staff in the field of Agricultural Machinery in any of the institutes. There is no adequate laboratory and field facility and class rooms are not well organized. These days Agricultural production is handled in a resource dwindling environment where the soil water and the echo system in general should remain healthy for sustainable agricultural production. Our Agricultural Engineering Institutes are expected to produce dynamic and responsive personnel who can be good researchers, technologist and managers, but the current set up does not look that they will fulfill these expectations.

The way forward

If life has to sustain on this planet, we cannot compromise on the necessity of increased agricultural production on sustainable basis. Though most of the state farms are now privatized and some of the Agricultural Engineering courses are deemphasized for some time and others are coming up, we would like to see closely the current agricultural mechanization setup in line with the challenges and the expectation it has to fulfill.

Sustainable agricultural production necessitates a wise mix of the bio-chemical inputs supplemented with proper agricultural mechanization technologies, which are technically feasible, economically affordable, socially acceptable and environmentally sustainable. This requires an integrated approach among all the actors in the Agricultural Mechanization System. The farmers, learning institutes, the research extension system, the policy makers, dealers, manufacturers all should perform to the maximum to sustain a viable the agricultural production system.

As indicated above, in the higher learning institutes Agricultural Mechanization is not strong and has been full hopes and despair if we look at the whole education system. Haramya, despite its long years of experience, there were ups and downs in its Agricultural Engineering programs and the section is not strong enough to face the challenges of meeting the demands from the Global economy, which requires handling the different mechanization technologies being introduced from abroad. Even the other universities should update their curriculum, so that their students will be ready to operate under these challenges, be innovative enough to deliver technologies, which will be efficient and precise enough to produce the required amount under this dwindling resource condition. In the Globalized world, technology does not have boundary and our trainees should be competitive on world market, so that they are not going to be relegated to the status of casual labor, but remain competent designers, scientists and managers, who will assure sustainable agricultural production. To achieve these universities should revisit their curriculum, strengthen their infrastructure and convince the policy makers to have strong agricultural mechanization program.

The Ministry of Agriculture through its investment directorate is creating the opportunity for investors to be involved in Mechanized Agriculture. Land is a limited resource and extensive farming is not always the solution.

As the process of colonization by agriculture to forest lands continues, areas often characterized by steep slopes and vulnerable to erosion are exploited. In order to appreciate, the environmental consequences of converting tropical forests to agricultural land, it is necessary first to understand the environmental dynamics of undisturbed forest. In clearing forest for other land uses, patch clearing like in shifting cultivation, giving time for the vegetation to catch up to the required level, farming with adequate conservation measures and selecting the proper crop taking the slope into account could minimize the damage if not avoid the problem totally..

In order to avoid the above stated problems an adequate assessment of the forest land including identification of sensitive areas like steep slopes, wet lands and shallow soils, water ways need to be avoided to minimize the damage. Where ever possible conservation agriculture will have the advantage of keeping the land, soil and nutrient from further degradation.

Where forest has been converted it is our duty to make sure that sound land husbandry is practiced acknowledging what is here today, rather than lamenting what has been lost forever. The policy makers should work on a sustainable mechanization system, where proper land use and classification system are place and an encouraging mechanization system, which encourages investors, insures the livelihood of the people and sustainability of the resource and ecosystem.

As the whole effort is to assure sustainable agricultural production, which will be feasible if all the actors in the system turn out to be beneficiaries. In this system we have to make sure that environmental and social safeguards are adhered to . The livelihood of the people should be assured and the environment should be sustained so that sustained production is possible probably we have to think of a method, which always regenerate the environment, but not keep on mining the system to complete depletion.

The research and extension system has been delivering technologies, which some have reached the end user, but most still remain on the shelf. Research outputs have not been multiplied to the extent we would have liked it to be. No manufacturer has taken up farm implements production as a full time venture. This could be attributed to the technology efficiency, the policy environment, affordability of the technology. The delivery of refined technology will come out as a result of generating skilled personnel from the training institutes, others will be the readiness of financial institutes to avail credit both to the manufacturers and farmers as well. This requires that we think of a viable business model where all the actors in the chain meet the requirements and benefit as well. This requires that the policy environment need to be worked out to meet the challenges.

Information is vital for planning Agricultural Mechanization system and sustainable operation. The data available should be properly collected, verified and documented so that a reliable information could be derived, which will be helpful in designing proper implementation plan. Agriculture is the most important economic sector in Ethiopia. Most people earn their livelihood through agriculture.

Increasing the productivity and a more optimal and efficient use of resources is the option to meet the current demand and future needs on sustainable basis without jeopardizing the future use of the land resource. As there is a huge gap (20-60%) between the yield potential and current production of most crops, it is necessary to use a complete package of production technology, where mechanization is an important component.

The selection of the optimum mechanization level depending on land size and length of the growing period and the window of operation time for the most critical operation is very important. Farmers should be aware to use the most efficient level of mechanization, in order to utilize the small window of operation period as observed in most sub moist zone to use the whole growing period, the big farms should be able to produce beyond the national average, by improving the skill and discipline of their operators to focus on effectiveness and precision to insure optimal yield today without jeopardizing the future use of the resource base.

Agricultural Machinery dealers should think beyond profit, but also think in terms of the sustainability of the system. They should think of importing technology, which will be suitable to the environmental, soil and terrain of the country. They should have enough stock of fast moving parts and must be able to provide after sales service in the country. This should be supplemented with a provision of training to the operators and the farm technicians to handle routine maintenance . They should make sure long idle and down times are not recorded on the farms, the business flow should be smooth and attractive to the farmers operators, business and the country at large.

Continuous supply of food and fiber is necessary for the ever increasing population on the non expanding, but shrinking land resources. This requires that we cannot afford only to mine the land resource, but our production system should sustain and rehabilitate the resource base. This requires that our machinery mechanization system should fulfill these requirements. The system should not rely only on maximizing yield but sustainable production, which should be knowledge based, precise and efficient and rehabilitate the resource base at the same time.

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