AGRICULTURAL MECHANIZATION STATUS IN AFRICA: AN OVERVIEW

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ABSTRACT

One of the key aspirations of Agenda 2063 on the Africa we want is to consolidate the modernization of African agriculture and agro-businesses. Use of mechanical technologies which are both labour saving and directly increase yields and production is the most appropriate way of sustaining increased food production. It is therefore important that an appropriate technology, technology that is socially acceptable, economically viable and technically feasible, is selected for specific prevailing condition. Sub-Saharan Africa remains the region in the world with the lowest power usage (manual, animal and mechanical) and the lowest level of farm mechanization. In SSA the general average number of tractors is about 28 tractors per 1 000 ha whereas it is about 241 tractors in other regions. In order to enhance mechanization in Africa, governments have to place more emphasis on the development of small-scale farmers, support and encourage the existing advanced and successful commercial farming sector, provide in-service training for extension officers, artisans and other entrepreneurs to improve their understanding of the different power and mechanization options available to farmers and to expose them to new technologies and opportunities as well as strengthening input supply networks and promote the manufacturing base on agricultural operations and processing technologies.

Keywords: Mechanization, Agriculture, appropriate technology, selective mechanization

INTRODUCTION

One of the key aspirations of Agenda 2063 on the Africa we want is to consolidate the modernization of African agriculture and agro-businesses, through scaled up value addition and productivity, and by 2063: completely eliminate hunger and food insecurity, reduce the imports of food and raise intra-Africa trade in agriculture and food to 50% of total formal food and agricultural trade, expand the introduction of modern agricultural systems, technology, practices and training, including the banishment of the hand-hoe, develop and implement affirmative policies and advocacy to ensure women’s increased access to land and inputs, and ensure that at least 30% of agricultural financing are accessed by women; and economically empower women and youth by enhancing access to financial resources for investment (Union, 2015).

For the bulk of African countries, agricultural sector remains to be the backbone of the economies providing relatively large share of the Gross Domestic Product (GDP). However, the productivity in this sector has dawdled considerably behind that of other continents as well as the potential that Africa can reach in the sector. While on average agriculture employs 65% of Africa’s labor force it accounts for about 32% of gross domestic product, reflecting the relatively low productivity in the sector.

Farm production can be substantially increased through the use of mechanical technologies which are both labour saving and directly increase yields and production. Inputs of hard labour by farmers and their families can be substantially reduced if they have access to a carefully selected use of tools, machines, and equipment. Use of improved
mechanical technologies can also have a direct impact on yields and area under production. Such technological interventions are commonly referred to as agricultural mechanization. In a rural context the term also extends to cover other closely related small scale activities such as the primary processing of agricultural products, on-farm storage, and the delivery of irrigation water.

Agricultural Mechanization

According to FAO (Clarke, 1997), Agricultural Mechanization encompasses the use of hand tools and animal drawn implements as well as motorized equipment to reduce human effort, to perform certain farming operations that cannot be accomplished by other means or within the time available and to improve the quality of others, i.e. a means of enhancing human inputs for performing operations for or in production. Mechanization is considered as a set of technological expertise to ensure enhancement of productivity by introducing timely field operations and quality of grain (Kepner et al., 2003).

Selective Mechanization

This refers to the type of mechanization that fits a country’s economic, employment, production and cultural needs or any form of mechanization that does not decrease the demand for labour per unit land (removing labour peaks, intensification of production, multiple cropping etc.). Production, mechanization and employment are related problems and machines and labour are essential inputs for production but not necessarily rival inputs as we are too often led to believe.

Appropriate Technology: Technology that is socially acceptable (SA), economically viable (EV) and technically feasible (TF) i.e. technology applicable to the poor as well as the rich, developed and developing countries all for human race survival as an entity.

SA - Considers socio-economic (literacy) and cultural aspects i.e. lifestyle and labour division, local faith, use of child labour and gender issues.
EV - Considers cost, timeliness, C/B ratio, industrial back-up, credit availability among others.
TF - Considers power supply, field performance, labour supply and infrastructural support.

Current Status of Agricultural Mechanization in Sub-Saharan African Countries

In SSA the total cultivated land area is about 2 455 million ha of which 173 million ha are under annual cultivation. Farming systems are dominated by small-holder peasant farmers which in most cases are based on subsistence farming. The average landholding of farmers is less than 2 hectares. Fertilizer use is far less in SSA than it is in the rest of the world. For example, in 2007 average fertilizer use was only 13 kg per hectare, compared with 208 kg in Asia and Latin America (Table 1). The area under irrigation in SSA accounts for only five percent of cultivated area, compared to more than 38 percent in a selection of other countries in Asia and Latin America.
Mechanization Adoption Process

Figure 2: Mechanization adoption process flow diagram

Table 1: How Africa compares with other developing regions

| Region          | Cereal yield (kg/ha) | Fertilizer use (kg/ha) | Irrigation percentage of arable land | Tractor per 1000ha |
|-----------------|----------------------|------------------------|-------------------------------------|--------------------|
| Africa          | 1040                 | 13                     | 5                                   | 28                 |
| Average of 9 selected countries | 3348                 | 208                    | 38                                  | 241                |

Source: The World Bank (2007) as cited by FAO and UNIDO (2008)

Studies show that Sub-Saharan Africa (SSA) remains the region in the world with the lowest power usage (manual, animal and mechanical) and the lowest level of farm mechanization. In SSA the general average number of tractors is about 28 tractors per 1 000 ha whereas it is about 241 tractors in other regions (Table1). In SSA the principal power source is humans who dig, by hand, between 50% and 80% of the area under cultivation (Clarke, 1998). The use of manual power dominates in Central Africa whereas in Western and Eastern Africa more use is made of draught animals. In SSA, tractor usage is highest in Southern Africa (Figure 3).
Figure 3: Percentage uses of different sources of power in agriculture in four regions in Africa (Clarke. FAO 1998)

Table 2: Farm power sources (percentages)

| Region                  | Hand | Animal | Engine |
|-------------------------|------|--------|--------|
| SSA                     | 65   | 25     | 10     |
| 3 other developing regions* | 25   | 25     | 50     |

* Asia, Near East and North Africa, Latin America and Caribbean. (Source: FAO, 2005, World Agriculture, Towards 2015/2030, Table 4.16).

Figure 4: Farm power sources (in percentages) in Africa, Asia and Latin America (FAO, 2008)
Levels of agricultural mechanization

Africa is dominated by family farming, which relies mainly on family labour. Africa has 33 million farms of less than 2 hectares, accounting for 80% of all farms. While the agricultural labour force is comprised mostly of women, rules governing ownership and transfer of land rights are less favorable to women than in Asia and Latin America. Over the last 10 years, large-scale investment contracts in Africa have covered 20 million hectares, which represents more than the arable area of South Africa and Zimbabwe combined. In Eastern Africa countries, average manual labour is at about 55%, animal power (30%) and engine power at 15% and indicated in Table 3.

Mechanization based on different prime movers

Figure 5 outlines the Effective Field Capacities (EFCs) for numerous prime movers. It is appreciated that the high the power capacity the larger the field coverage within a day for a given mechanization system. The capacity of human beings is low; hence the need to use them as managers of power against sources of power.

Table 3: Mechanization Situations in the Eastern Africa

| Mechanization level (%) / Power Source | Country / Region |
|---------------------------------------|------------------|
|                                       | Kenya | Rwanda | Tanzania | Uganda | EA | SSA |
| Human Power                           | 50    | 98 (95) | 55       | 60     | 55 | 65 |
| Animal Power                          | 30    | 1.5 (4) | 35       | 25     | 30 | 25 |
| Engine Power                          | 20    | 0.5 (1) | 10       | 15     | 15 | 10 |

Source: Gitau at el, (2010)

Table 4 gives a comparison between numerous power sources for soil tillage from animal power to 100 HP tractive prime-movers.

Figure 5: Effective field capacities (ha/day) for different prime movers (Gitau at el., 2010)
Sources of farm power and their effect on productivity

Table 4: Prime movers’ options for tillage

| Prime-Mover                      | Speed (km/h) | Width (m) | Ploughing efficiency (%) | EFC (Ha/h) | Hours per day | Coverage (Ha/day) |
|----------------------------------|--------------|-----------|--------------------------|------------|---------------|------------------|
| Human                            | 1            | 0.15      | 60                       | 0.0090     | 7             | 0.063            |
| A pair of oxen (500 kg)          | 3            | 0.30      | 70                       | 0.0630     | 7             | 0.441            |
| Walking tractor (15 HP)           | 5            | 0.60      | 75                       | 0.2250     | 7             | 1.575            |
| 35 HP Tractor                    | 6            | 0.75      | 75                       | 0.3375     | 8             | 2.700            |
| 50–60 HP Tractor                 | 7            | 0.75      | 80                       | 0.420      | 8             | 3.360            |
| 80 – 100 HP 4WD Tractor          | 10           | 1.00      | 80                       | 0.800      | 8             | 6.400            |

Source: Gitau et al., (2010)

In terms of area to be cultivated, the use of hand tools puts a limitation on the area that can be cultivated by one person (Figure 6). Within this overall limitation, the amount of time it takes to accomplish various farming operations will nevertheless vary widely according to considerations such as the crop, soil type, soil moisture, optimum seeding dates and desired quality of work. The amount of work a human can deliver is influenced by nutrition and health. Climatic conditions also play a significant role; in particular, high ambient temperatures and humidity drastically reduce human work capacity.

There is considerable evidence to show that by replacing and augmenting human power with animal traction, the total cultivated area can be expanded and labour productivity increased (Figure 6). The rate of work achieved by work animals varies considerably but can be from 5 to 20 times greater than manual labour. The introduction of mechanical power into agriculture has normally brought about increases in both labour and land productivity. Not to be underestimated is the reduction in drudgery that generally results from mechanizing operations. For example, it has been estimated that a mechanized farmer can provide enough food to feed up to fifty people whereas by using draught animal power alone a farmer can only feed about six others (Clarke, 2008).

Challenges Facing Mechanization in Africa

• Inadequate machinery

Table 1 indicated that other developing countries have about ten times as many tractors per unit of farmland as those in SSA. Currently, there are about 470 000 tractors in Africa, but little is known about their age or working condition. A simple calculation suggests that to bring the level of power to agriculture to that which other developing countries have achieved, this annual market would have to expand by a factor of about ten to approximately 400 000 tractors per year. Such a growth in tractor sales cannot be achieved immediately but could be in, say, 10 or 12 years. This would require urgent action to stimulate the market to attain sales of the order of 100 000 units per year within
Local Manufacturing and Distribution

In Africa’s hand-hoe-powered agriculture, it is hardly surprising that very little industrial development has taken place to manufacture or even assemble machinery for agriculture. A few farm tool and implement factories have been established, mainly in South Africa, Zambia, Kenya and Zimbabwe. Few efforts in other countries have survived competition from the importation of low-cost tools from countries in other continents (e.g. China and India). The manufacture and even assembly of tractors and irrigation pumps has been limited to a very few underperforming enterprises, mainly in North Africa. It is clear that, if the tractor and irrigation markets could be expanded, the opportunities for African manufacturing industry would also expand. At the same time, the number of implements that would be required could stimulate the growth of implement manufacture on a wide scale across the continent.

The Way Forward

Structural and institutional changes

Before the mechanization opportunities can be fully exploited, a number of issues need to be addressed, such as:

Structures of landholding and landownership: Farmers should be able to buy and sell land and enjoy full entitlement of their holdings. In this way, there will be a possibility of using their farms as collateral for loans to invest in machinery.

Fiscal regime: The development of commercial agriculture and the industrial enterprises associated with it need a supportive fiscal regime in which taxes are low and barriers, such as import duties on agricultural machinery, spare parts and raw materials for local manufacturing, are minimized.

Finance: Increased capitalization of agriculture needs sources of finance on favorable terms. The financial sector, with agribusiness type intermediaries, should work with commercially-oriented farmers and entrepreneurs in order to strike the necessary financial deals that are required for increasingly commercialized farming.

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Figure 6: Sources of farm power and their effect on productivity (Karim et al., 2013)
**Education and training:** Training is necessary and paramount, not only for farming skills but also for management of farm machinery and other technologies, finance, forward planning, and marketing.

**Research and extension:** The technology that farmers require needs to be locally sourced and adapted to local conditions in a continuous process of research, adaptation, extension, monitoring and evaluation.

**Input sourcing:** Farmers must have local access to the inputs they need, including seeds and fertilizers, electricity and water as well as machinery and the supporting infrastructure that mechanization requires (e.g. repair services, parts supply, fuel and lubricants).

**Building partnership**

A broad partnership is required between the public-sector and private-sector agencies and actors.

**Governments**

Governments should be encouraged to facilitate and support such initiatives. Special government tasks will cut across infrastructure, education, health, transport, water resources, fiscal measures and legislation. The ideal situation has been described as the “Triple Helix Model” in which government, public institutions and industry are entwined in a mutually supportive cooperative endeavor. Governments have a role in the broad field of education and training, in the creation, funding and management of institutions responsible for the acquisition of knowledge (research), and in its dissemination. Specialized institutions are needed, geared to supporting agriculture in general or farm mechanization in particular. They may be national in character, or regional for countries facing common problems with possible common solutions. Government should facilitate the process of agricultural mechanization development. Government may have a role in facilitating trade relationships with new suppliers of technology or equipment. Government may need to make the first moves, such as importing the first consignment in partnership with the private enterprise, and thereafter allowing it to take over. Support with supply and demand contacts, management and finance securities or tax waivers would help the private sector to come up to speed in a relatively short period.

Governments also have a role in maintaining standards. In the case of farm machinery, standards may be specified in relation to the local conditions and, more generally, to quality and the provision of service support. Standards may also be laid down in regulating the farm output marketing infrastructure and in maintaining food quality and hygiene.

**Private Sector**

The private sector is better equipped to look after the day-to-day provision of farm inputs including farm machinery and the associated vital machinery support services. Operations are best conducted under commercial enterprises requiring adequate investment and offering the opportunity to make profitable commercial returns. Local manufacturing can be logically preceded by profitable importation, assembly and distribution support businesses. Building close relationships with the farmers, assessing needs and satisfying demands, while competing with peer companies, are all part of the business venture. In this kind of operational scenario, demand for mechanization is likely to be satisfied and agricultural productivity enhanced. Farmers are the key actors. African farmers need assistance to expand their horizons to the opportunities that may be exploited to farm on a larger scale. They need to intensify their cropping and productivity by investing in inputs such as seeds, fertilizer, irrigation and farm equipment, with a view to fully participating in the cash economy and bringing its benefits to their families and communities.

**International organizations**
International technical institutions such as UNIDO and FAO have a role to play in bringing their expertise to bear on the problems and challenges described above. In particular, UNIDO and FAO can offer a holistic approach developed over many years in a wide range of situations. FAO can assist in producing Agricultural Mechanization Strategies (AMSs) for specific countries or regions. UNIDO has developed analytical tools to put the whole Agricultural Machinery Industry System (AMIS) in perspective for development purposes. International financial institutions such as World Bank (WB), the African Development Bank (ADB) and the International Fund for Agricultural Development (IFAD), as well as foreign government sources, may be invoked in tackling the funding needs of the plans suggested (FAO & UNIDO, 2008).

CONCLUSIONS

Agriculture remains the most integral sector of the Africa’s continent economy. To reap maximum benefits, the continent has to borrow a leaf from Asia on key driving factors for the uptake of mechanization in Asia in the 1970s and 1980s. These include:

- The presence of a sizable number of farms in business able to invest in machinery and to provide mechanization services to neighboring farmers.
- Mechanization of power-intensive processing and pumping operations that complement the mechanization of crop husbandry and harvesting operations.
- Availability of registered land that affords farmers an opportunity to use the title deeds as collateral for credit to purchase machinery or more land.
- Policies encouraging industrialization resulting in high levels of demand for mechanized equipment, leading to the development of low-cost equipment (e.g., power tillers and diesel engines).
- Farmers’ entrepreneurial skills and adaptive management capacity to changing markets, technologies and policies including opportunities to use agricultural machinery for off-farm and non-agricultural activities such as transportation and infrastructure maintenance.

RECOMMENDATION

In order to enhance mechanization, input in Africa, we recommend the following actions;

- Place more emphasis on the development of small-scale farmers.
- Support and encourage the existing advanced and successful commercial farming sector.
- Provide in-service training for extension officers, artisans and other entrepreneurs to improve their understanding of the different power and mechanization options available to farmers and to expose them to new technologies and opportunities.
- Strengthen input supply networks and promote the manufacturing base on agricultural operations and processing technologies.
- Promote environmentally friendly mechanization practices that will result in sustainable economic growth.

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