AGRICULTURAL MECHANIZATION: A MAJOR INPUT AND DRIVER FOR SUSTAINABLE AGRICULTURAL TRANSFORMATION AND INDUSTRIALIZATION IN TANZANIA.

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ABSTRACT

Agricultural mechanization has been defined as a process of improving labour and farm productivity. There are basically three levels of mechanization: hand too technology; Animal drawn powered technology and mechanical power. The paper highlights the need to move from hand hoe technology in order to achieve the industrialization drive currently promoted by the Tanzanian government. Examples of possible areas for industrialization through the promotion of mechanization inputs have been discussed. It is argued that the promotion of mechanization inputs along the agricultural value chain can enhance the self employment, improve farm production levels and encourage small scale industries in rural areas.

Keywords: *Agricultural mechanization; agricultural transformation; rural industrialization*

1. INTRODUCTION

The future prosperity of Tanzania like many other developing economies, depends on sustainable growth in agricultural production and productivity coupled with protection of its natural resources and environment. Success in this will require employment of engineering technologies as a major inputs and instruments for promoting growth at all levels of agricultural development. The Tanzania vision for 2015 aims at transforming Tanzania into a semi-industrialised economy. The goal is to have the economy in 2015 transformed and highly competitive with productive agricultural activities which are effectively integrated and buttressed by supportive industrial and mechanized service in the rural and urban areas.

The following are the principal objectives and targets of the Vision 2025:

- Achieving quality and good life for all
- Good governance and the rule of law
- Building a strong and resilient economy that can effectively withstand global competition

Consistent with this vision, agricultural mechanization as a major input and driver for rural industrialization will contribute in meeting the following targets;

- High production and labour productivity
- A well educated and learning society
- A competitive economy capable of producing sustainable growth and shared benefits
- Food self-sufficiency and food security.

The Tanzanian Agriculture sector programme document (ASDP II) has a set of specific activities on commodity value chain development. If fully implemented, smallholder farmers will be able to mitigate and adapt to industrial growth as targeted by the government. These activities include:

- Establish district commodity value chain platforms (DCP) which could be useful for dissemination of various mechanized technologies.
- Farmers empowerment and organizational strengthening
- Linking farmers with agribusinesses to access mechanization inputs for sustainable productivity growth (which could include drought resistant OPV seeds)
- Encouraging delivery and adoption of demand-driven technologies. The project farmers will have the potential to demand for proven technologies and methods which could include agro-processing, farm machinery, access to finance and/or improved seeds

2. ISSUES RELATED TO AGRICULTURAL MECHANIZATION DEVELOPMENT

Agricultural mechanization has been defined in a number of ways by different people, but perhaps, the most appropriate definition is "the process of improving farm labour productivity through the use of agricultural machinery, implements and tools". Mechanization as Bishop and Morris (1992) clearly puts it, is a key input in modernization of any farming system. It involves the provision and use of all form of power sources and mechanical assistance to agriculture. As a major agricultural production input, mechanization aims to achieve the following

- Reduction of drudgery in farming activities and making farm work more attractive to end users and more specially to youth
- Increased productivity per unit area due to improved timeliness of farm operations
- Accomplishment of tasks that are difficult to perform without mechanical aids and
- Improvement of the quality of work and products.

It has been documented that Tanzania needs an average of 1,800 tractors annually against the current supply of 400 tractors annually. 70% of farmers in Tanzania still use hand hoe technology, 20% use oxen and only 10% have access to tractors. (Simalenga, 2016; Mrema 2004; Mrema 2016). Private sector involvement in agriculture has remained weak with very limited investment. The promotion of agricultural mechanization inputs (at all levels by all players including government) will trigger the process of Tanzania agricultural transformation.

There are Several Stages in the Process of Agricultural Mechanization as reported by FAO, 1981; FAO-AUC, 2017; Rijk, 1989 and Mrema 2016: These stages have been highlighted below:

Stage 1: Power Substitution Stage: This is the earliest stage in the mechanization process and involves draught animal power substituting human power or mechanical power substituting draught animal. In most cases the mechanization here is straight forward and the machinery tends to be simple and not so expensive. The key issue here is effective and efficient utilization of the power source through sustainable and profitable business models – otherwise somebody has to subsidize if not profitable.

Stage 2: Mechanization of the Human Control Functions: The emphasis here is the substitution of the human control functions. Depending on the complexity of the control function

then the machine/equipment can be quite complex. Examples here are hand weeding vs. mechanized weeding; manual cotton picking vs. mechanized cotton harvesting; manual harvesting of tea leaves vs. mechanized tea harvesting.

Stage 3: Adaptation of the cropping system to the machine: Difficult and/or too costly to mechanize certain human control operations – so instead change the cropping system to fit the machine. Examples include changing from broadcasting of seeds to row planting because of difficulties of weeding with machine in the later; changing from intercropping to mono cropping because of difficulties of mechanizing the former.

Stage 4: Adaptation of the Farming System and Production Environment to Facilitate Mechanization: Farming system adapted to increase labor productivity and benefit from economies of scale. Intensive poultry and livestock production; minimum and zero tillage systems; fully cleared land to facilitate mechanization; land planning and consolidation of fields to create larger fields to facilitate efficient mechanized tillage.

Stage 5: Adaptation of Crops to the Mechanization System: Through plant/animal breeding to facilitate mechanizing production activities e.g. harvesting; lodging; thresh-ability; or processing – ease of peeling; resistance to bruise damage during harvesting.

Stage 6: Automation of Agricultural Production (Precision farming): Higher levels of mechanization where many production operations are automated – automated feeding systems in livestock production; precision application of fertilizers; herbicides etc.
Figure 1 shows the benefits and contribution of mechanization inputs in agricultural transformation and rural development

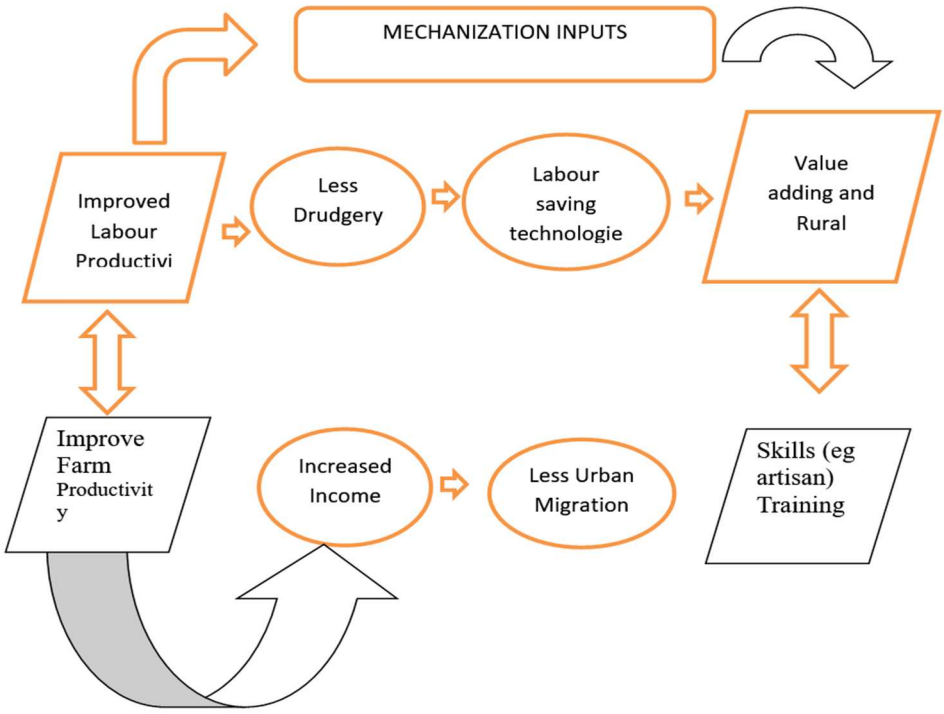


Figure 1: Schematic diagram showing issues and benefits of Mechanization

3. Mechanization Investment Across the Value Chain

Past analysis of agricultural mechanization in Tanzania and elsewhere in Africa tended to be confined to on-farm production issues and failed to capture the off-farm uses of machinery and implements where farmers who had invested in machinery and implements were realizing economies of utilization of their mechanization investments. It is, therefore of critical importance to widen the mechanization inputs to cover the entire agri-food chain from inputs through to on-farm production to post-harvest handling and processing issues as well as consumer protection i.e. food safety.

World wide experience shows that agricultural mechanization has been successful when there is an effective demand for the outputs of farming (including for on and off-farm value addition) and sustainability of mechanization systems has to factor in the entire agri-food chain. Also sustainable agricultural mechanization technologies can contribute significantly in programs for reducing losses along the entire agri-food chain. Such losses especially the post-harvest ones, are considerable in SSA of the order of up to 50% in some crops. Given current demographic trends, Mechanization will have to go beyond on-farm productivity issues to include post-harvest systems and the entire food chain.

4. Example of Farm Mechanization Inputs and potential areas for Industrial Investment

4.1: Farm power inputs for ploughing and ridging (Moving from handhoe to mechanized systems)



Figure 2: Highlights the potential mechanization inputs for ploughing and ridging Weeding Investment (Source: Dashell 2016-IITA Youth Agriprenuers Mechanization unit)

As shown in the Figure 2 above, making ridges using special designed machines can transform and change the face of the farming using hand hoe.

4.2: Tillage, special planting and weeding solutions

Figure 3 shows possible mechanized operations for planting and harvesting cassava crop. These machines are excellent opportunity for manufacturers to provide solutions for labour intensive operations and improve the efficiency of these operations.



Figure 3: Highlights of cassava planters on the left and cassava harvester on the right which can revolutionise the way we farm and harvest cassava crop. (Source: Dashell 2016)

4.3: Mechanized Weeding solutions (Crop care Solutions)

Weeding is one of the farm operation which require modernization using user friendly labour saving technologies and machines. Figure 4 shows possible solutions which can use motorized technologies for weeding maize or any row crop.



Figure 4: Showing the mechanized weeding operations using motorized machines. Youth can participate in agriculture activities with simple modernized weeding technologies. (Source: Dashell 2016)

4.4: Harvesting and On-farm Processing Solutions

Another potential areas in providing mechanization solutions and support the industrialization agenda in Tanzania is the use of motorized hand held harvesters and on-farm threshing and processing technologies. Figure 5 is examples of potential machinery for harvesting and on-farm processing operations.

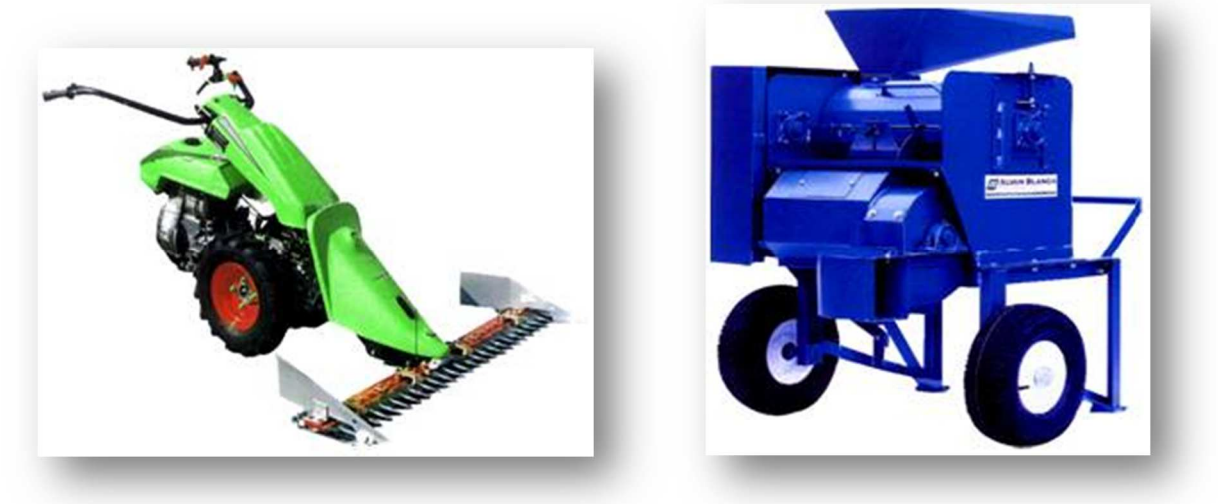


Figure 5: On the left is a simple harvester while on the right is on -farm threshing/shelling machine. (Source: Hatibu and Simalenga 1993)

5. PROMOTION OF AGRICULTURAL MECHANIZATION-LED HUBS AND CENTERS TO RAISE PRODUCTIVITY

The need of having a world class agricultural mechanization hubs and centres of excellence in a developing country like Tanzania cannot be overemphasized. Tanzania is one of the peaceful country in SADC and enjoys favorable policies, stability, good relations with its neighbours and committed staff which will make the achievement of the above goals possible. For the past few years, the Government has been implementing the voucher system support to farmers in providing subsidized seeds and fertilizer. The proposed mechanization hubs initiative will build on this support and extend the current voucher of input supply system and include farm machinery services for plowing and agro-processing as part of the transforming agricultural production system.

It has been reported that the potential demand for improved seeds in Tanzania is about 120,000 tons per annum. The average annual supply for the last four years has been 10,000 tons. Similarly, Tanzania uses 9 kg of fertilizer per hectare of arable land. Malawi uses 27 kg per hectare while South Africa uses 53 kg per hectare. On average SADC countries utilizes 16 kg per hectare. With respect to mechanization inputs, the story is even worse. Hand hoe technology dominates farming in Tanzania leading to low level of production. (Mrema 2016). All these

scenarios has been attributed to low level of involvement of private sector in agricultural input business.

The introduction mechanization hubs will also seeks to empower the local population (especially women and youth) by creating an environment for income generation and job creation through agro-processing and transport activities. The poverty and food security challenges in rural and urban areas, will be addressed through this initiative. Under this initiative, all technologies will be stored under one roof as shown in Figure 6 and through this mechanization hub concept, farmers will be able to access the technologies they want on demand without incurring the cost of purchasing each technology for each operation.



Figure 6: Showing a sketch on mechanization hub storage facility for farm machinery and other motorized on-farm technologies. (Source Simalenga 1995)

6. POTENTIAL AREAS FOR INDUSTRIAL INTERVENTION FOR SUSTAINABLE AGRICULTURAL MECHANIZATION AND AGRO-PROCESSING BUSINESS VENTURES

It is generally agreed that agriculture will continue to be the most important sector in the economy of most African countries. Therefore, it is logical to re-direct efforts towards this sector. One way of promoting sustainable agricultural development is to promote private sector participation through entrepreneurs in agricultural mechanized operations and Agro-processing business ventures.

The following are some of the possible areas and opportunities for industrial intervention in view of strengthening or initiating entrepreneurship in the region.

(a) Manufacturing of agricultural machinery, implements and parts

The main objective here is to promote the manufacturing base on agricultural operations and processing technologies. The goal is to increase availability of agricultural machinery and equipment. Examples of these technologies include:

- Production of agricultural machinery suitable for rural areas:
- Production of spraying and transport equipment:
- Manufacture of crop processing, handling and packaging equipment (shellers, threshers, oil expellers' etc.);
- Manufacture of fruits/vegetable processing and packaging equipment.

(b) Agricultural processing industries and food technology systems

The main goal here is to increase processing and storage capacity and marketing of agriculture produce. Some examples in this area include:

- Fruit and vegetable processing and canning;
- Livestock products processing and packaging;
- Processing, packaging and marketing of commodity crops;
- Animal feed production;
- Apiculture (bee) products processing and packaging;

(c) Farming and provision of services to farmers and agro-industries though mechanized hub concept

The main objective in this area is to develop scientific commercial and profitable farming servicing centres for both local and external market. This can include:

- Privately owned contract hire services for both farm machinery and agro-processing units;
- Horticultural agricultural mechanized hubs for crop production;

(d) Marketing of technology-oriented hardware, inputs and processed products

Here the main goal will be to increase supply of technologies, spare and services to farmers and agro-industries. This will include:

- Trading, importation and distribution of farm machinery and other technologies;
- Commercialization of processed products through marketing networks;
- Provision of maintenance and repair services and supply of inputs and spares (dealership).

As stated in previous sections, the problems for starting and sustaining mechanized technology-oriented enterprises do not have a magic formula to solve them. They require both re-orientation of policy implementation towards micro-enterprises, deliberate government intervention in creating enabling environment and a strong mechanism to make follow up and support the entrepreneurs.

Financial markets need major reform in order to provide the required finance to support technology oriented entrepreneurs. This can be achieved by setting up of special revolving loan funds or by provision of accessible credit facilities.

Appropriate policy framework such as National Agricultural Mechanization Strategy, needs to be in place so as to ensure that the enabling environment is created and sustained to run the business as profitably. The strategy will also assist to identify the required infrastructure and other sectors of the national economy to be developed to support agricultural development.

Education and training will need to be reviewed in-line with the changing economic environment. Courses such as business and capital management, application of information technology in agribusiness will have to be incorporated as well as entrepreneurship training in universities, colleges, and professional training courses started.

A mechanism for information for business and market (Networking) will need to be established for regional collaboration, promotion and publicity. The mechanism will also initiate the formation of data bank especially for regional trade and tariffs and market opportunities. This will greatly assist regional networking for one-stop-information acquisition system.

7. CONCLUSION

The paper has attempted to show that agricultural mechanization is a viable economic activity which can enhance the quality of life and bring in added value from the use of natural resources. It thus deserves support in terms of investment. Development and modernization of Africa's agriculture and its agro-industries will depend to large extent on the transformation of policies, educational and entrepreneurship thrust. It is argued that for sustainable agriculture growth to take place in the medium and long term, there is need to change policy from emphasis on small-scale peasant farmers to medium scale African commercial farmers. Entrepreneurship and professionalism in agricultural mechanization are likely to be the main key to the sustainable development of Tanzanian agriculture.

For agricultural mechanization-led industrialization to happen, there is a strong need for research and development institutions in agriculture to work in tandem with the private sector to develop technologies that will address issues identified in ASDP-II. Improved primary and secondary farm operations and value addition in the relevant in post-harvesting processes will provide the much needed boost in agricultural productivity and production. These actions will provide capacity for the agricultural sector to provide the much needed material supply for the industrial sector, which will then contribute the much needed GDP.

Agricultural mechanization is one of the important input that is required which will in the long run significantly contribute to the agricultural-led industrialization. This paper has analysed key areas which require agricultural mechanization to make significant contribution in the industrialization drive. It also recommends the strategic actions, which need to be implemented by the R&D institutions to bring about the much anticipated part of the agricultural-based industry along the whole value chain of agricultural production as shown in the figure 7 below.



Figure 7: The Value chain analysis in agricultural production and productivity

In conclusion, it may be said that given globalization and the resulting free flow of information, many Africans are able to see and learn from the progress in Asia and other parts of the world where mechanization of agriculture has occurred, over the past five decades. It is for, among other reasons, that there is an urgent call to send the hand-hoe to the Museum within the coming

decade and in so doing liberate the African farmer from the drudgery associated with primary land preparation using this hand-hoe technology.

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