ISBN No: 978-955-9224-62-4

National Research Priorities on Agricultural Mechanization

2017-2021

National Committee on Agricultural Mechanization

ISBN No: 978-955-9224-62-4

National Priorities in on Agricultural Mechanization 2017-2021

Committee Members of
National Committee on Agricultural Mechanization

▪ Prof M A R V Fernando	Faculty of Engineering, University of Moratuwa.
▪ Prof P L G Alwis	Faculty of Agriculture, University of Ruhuna, Matara.
▪ Dr M A Wijeratne	Tea Research Institute of Sri Lanka Talawakelle.
▪ Dr Sumith Senarathna	Coconut Research Institute, Lunuwila.
▪ Dr Wasantha Seneviratne	Rubber Research Institute of Sri Lanka, Agalawatta.
▪ Mr Ranjith Rajapakse	JE Tech Pvt Ltd, Ja ela.
▪ Eng W K R Peiris	National Engineering Research and Development Centre of Sri Lanka, Ja ela.
▪ Mr K H Dimuthu Abeyratne	Sugarcane Research Institute, Udawalawa.
▪ Eng H M A P Rathnayake	Institute of Post-Harvest Technology, Anuradhapura.
▪ Mr Priyananda Dissanayake	CIC Pvt Ltd, Colombo.
▪ Eng G A M A Wijethunga	Farm Mechanization Research Centre, Mahailuppallama.
▪ Mr Sameera S Dissanayake	Coordinator National Committee on Agricultural Mechanization, Sri Lanka Council for Agricultural Research Policy.

Message from the Chairman,

Sri Lanka is yet a primary agricultural country with about 28% of the population directly involved in primary production of food to meet the national targets. Although the country is self-sufficient in rice food import bill is substantial share of the national expenditure which amounts to about 200 billion per year.

Rice is the major crop covering an extent of 1.2 million hectares and the high trend of mechanization is now seen only in rice production it has taken almost half a century to research the current degree of mechanization in rice cultivation where land preparation harvesting threshing and processing has achieve higher degree of mechanization. The fact remains that most of the machinery and in agriculture is important.

The other crop which largest extent about 390 000 hectares is coconut where whole sector is still traditional in production and processing. Third largest extent is tea covering an extent of 210 000 hectares where initiatives has been made to introduce mechanization in planting primary harvest. The fact that availability of labour while wages of the worker goes up increasing the cost of production making Sri Lanka less competitive in the world market.

Sri Lanka produces almost all the vegetables required for national consumption. However cost shears for labour in vegetables is 50-60% of the total cost of production resulting in low profit margins of the farmers

Time has come to modernize and diversify agriculture in Sri Lanka and make agriculture an attractive profession to youth and youth engaged in agriculture as an agri-business. Towards these objectives national policy on mechanization of agriculture is urgently required to identify the policy interventions required.

Dr S D G Jayawardena

Chairman

Sri Lanka Council for Agricultural Research Policy

Message from the Secretary,

The main function of the Sri Lanka Council for Agricultural Research Policy (SLCARP) is to advise the Government on all matters regarding the organization, co-ordination, planning and execution of agricultural research in Sri Lanka. Research in the agricultural Mechanization comprises research in the plantation and non-plantation, with mainly 6 institutions. Planning and execution of research programmes according to the national needs towards the development goals is the top priority of the country is facilitated in those institutions. Hereby I am proud to present the new direction the research priories in mechanization to research and development.

In this documentary the National Committee on Agricultural Mechanization at SLCARP has identified the major labour demanding steps and divided trust areas, where the research activities are top of the priorities.

The Council greatly appreciate the effort commitment and co-operation shown throughout the task of developing this document by the committee members with Dr M A Wijeratna Chairman of the committee/Editor in Chief.

Dr J D H Wijewardena

Secretary

Sri Lanka Council for Agricultural Research Policy

Committee Members of
National Committee on Agricultural Mechanization National Committee on Agricultural Mechanization

▪ Prof M A R V Fernando	Faculty of Engineering, University of Moratuwa.
▪ Prof P L A G Alwis	Faculty of Agriculture, University of Ruhuna, Matara.
▪ Dr M A Wijeratne	Tea Research Institute of Sri Lanka Low country Regional Center, Ratnapura.
▪ Dr Sumith Senarathna	Coconut Research Institute, Lunuwila.
▪ Dr Wasantha Seneviratne	Rubber Research Institute of Sri Lanka, Agalawatta.
▪ Mr Ranjith Rajapakse	JE Tech Pvt Ltd, Ja ela.
▪ Eng W K R Peiris	National Engineering Research and Development Centre of Sri Lanka, Ja ela.
▪ Mr K H Dimuthu Abeyratne	Sugarcane Research Institute, Udawalawa.
▪ Eng H M A P Rathnayake	Institute of Post-Harvest Technology, Anuradhapura.
▪ Mr Priyananda Dissanayake	CIC Pvt Ltd, Colombo.
▪ Eng G A M A Wijethunga	Farm Mechanization Research Centre, Mahailuppallama.
▪ Mr Sameera Dissanayake	Coordinator National Committee on Agricultural Mechanization, Sri Lanka Council for Agricultural Research Policy.

Contents

Preamble

Contributing to about 8% of the GDP, agriculture sector plays a pivotal role in the economy of Sri Lanka. Nevertheless, the shortage of workers in agriculture is often blamed to be a cause of low land productivity and quality of produce. Additionally, climate change has also imposed limitations for increasing productivity of agricultural lands threatening food security. The declining quality of agricultural produces due to lack of labour required for good agricultural and manufacturing practices also results in poor prices realized in the international markets. Further, quality and price of a product are two of the most important and decisive factors in the arena of the international market for facing competition among similar products coming from different countries. Therefore, mechanization of labour intensive practices in agriculture as a solution to the scarcity of labour has been one of the most frequently discussed subjects among stakeholders. Increasing worker productivity, attract younger generation to agriculture, improving product quality, reducing cost of production, ease of manual operations, precise and timely cultivation, time saving and changing the attitude towards farming are some of the objectives of mechanization. Even though some field practices have been successfully mechanized, there is still a great potential for mechanizing the agriculture sector in Sri Lanka. Fragmentation of farmlands, irregular land shapes, and reducing the size of a holding have also become a challenge in mechanizing field operations. Presently, most of the machinery used in the agriculture sector are imported from other countries spending a colossal amount of foreign exchange every year. Lack of resources for research and development and manufacturing machinery, high cost of production compared with that of importing countries, lack of incentives for local producers and a small local market etc., have been some of the reasons for limiting local production of agriculture machinery and equipment. Further, there had also been complaints from the agricultural community and local producers that the progress of producing local machinery is badly hampered due to certain counterproductive government policies (e.g. taxes on imported raw materials etc.)

Agriculture sector in Sri Lanka mainly comprises of paddy, Other Food Crops (OFC), plantation crops, minor export crops, horticulture and fruit crops, floriculture, livestock, firewood and forestry. Additionally, fishing and aquaculture are also contributing to the agriculture sector of Sri Lanka.

This shows that the variety of machinery required for agriculture sector vary from small hand-held tools or equipment to large scale engine-driven machines. Further, every field or processing practice in agriculture cannot be successfully mechanized replacing manual operations due to various reasons. Presently, protected agriculture, especially for producing vegetables, fruits and flowers has received greater attention of enthusiastic entrepreneurs in the country. It is a well-known fact that mechanization is an important component in precision agriculture. Therefore, mechanization needs of this sector should also be addressed with a greater attention. Finding solutions through mechanization to facilitate compost preparation, reduce chemical usage in agriculture and minimize wild animal damage to cultivated crops and finished products has also become necessary.

With lesser restrictions on imports, substantial quantities of agricultural machinery are imported to Sri Lanka. Hence, it is paramount that a proper quality assurance and certification system is developed and imposed to safeguard the local farmers and other users of agricultural machinery. The local designers and manufacturers claim that it has been extremely difficult to continue their industries due to financial constraints and hence, government interventions are required for providing financial support and other required facilities. Further, a number of machines and equipment designed and developed locally to suit local conditions have not reached the end users due to problems of commercialization. Therefore, appropriate steps should be taken after a careful appraisal to rectify this situation. It will also be of advantage, if both local designers and manufactures are exposed to advanced technologies available in foreign countries. This emphasizes the need for private and public sector partnership in the development and manufacture of agricultural machinery. Moreover, machinery and equipment suitable for small-scale and village-scale agriculture should be produced with a view to increasing job opportunities for rural population, which is often considered as the back-born of the agriculture sector of Sri Lanka. In order to harness the full benefits of agricultural mechanization, new varieties and farming systems also need to be developed to suit mechanization.

Mechanization has been one of the factors attributable for the success of urban and industrial economies. Besides improving production efficiency, mechanization encourages large-scale production and improves the quality of farm produce.

Nevertheless, it can contribute to environmental pollution and soil erosion, and displaces farm labour. Hence, energy use efficiency, contribution to environmental pollution and also worker safety aspects should be given due attention at the research and development stage of agricultural machinery.

When the above factors are considered, it is clear that the priorities for mechanization of agricultural practices should be carefully identified by weighing pros & cons and the sector requirements. This publication compiled by the National Committee on Agricultural Mechanization identifies the most important areas of the agriculture sector in Sri Lanka that need to be urgently mechanized and types of machinery required.

National Priorities in Agricultural Mechanization

Agricultural Mechanization

Mechanization means to use machines to accomplish tasks or operations. A machine may be as simple as a wedge or an inclined plane, or as complex as an airplane. But in a more formal sense, a machine is a device or mechanical contrivance consisting of two or more relatively constrained components which are connected to a power source to transmit or modify force and motion to accomplish some desired kind of work. In contrast, a tool is a human powered instrument or implement usually without parts that move relative to one another, like a mammoty or a dibber, used to facilitate mechanical manual operations. Agricultural mechanization, therefore, is the use of any machine to accomplish a task or operation involved in agricultural production.

The history of agriculture contains many examples of using tools, but only in the recent times that the highest rate of machine use has been found. The first pervasive mechanization of agriculture came with the introduction of the plough, usually powered by animals. It was invented in ancient Mesopotamia. Current mechanized agriculture includes the use of Tractors, Inter-cultivators, Sprayers, Trucks, Combine harvesters, Airplanes (crop dusters), Helicopters and other special vehicles. Modern farms sometimes use smart devices in conjunction with satellite imagery and GPS guidance for remote operations of machinery.

1. Land Preparation

The land preparation is the most important practice in crop production and much power is used for this purpose. Out of the total cost of production in agriculture, 25% - 50% is spent for tillage. Depending upon the operation, penetration may range from 6 to 30 inches (150 mm to750 mm).

Tilling was first performed via human labour. Animals could also be used for tilling soil by trampling. The wooden plough was then invented. It could be pulled by mule, ox, elephant, water buffalo, or similar sturdy animal. Soon after 1900, the farm tractor was introduced, which eventually made the modern large-scale agriculture possible.

Land preparation is usually defined as the mechanical manipulation of the soil aimed at improving soil conditions and crop production. In agriculture, tillage is the preparation of the soil for planting and the process of keeping soil loose and free from weeds during the growth of crops. It is generally done to create a favourable condition for seed placement and plant growth.

Tillage operations are often classified as initial tillage and inter tillage, although the distinction is always clear-cut. The initial tillage operation is defined as a tillage practice which is conducted before crop establishment and the inter tillage operation is defined as a tillage practice which is conducted after crop establishment. The initial tillage operations for seedbed preparation are often classified into two sub category i.e. primary or secondary tillage, although the distinction is not always clear-cut. A primary tillage operation constitutes the initial, major soil-working operation; it is normally designed to reduce soil strength, cover plant materials and re-arrange aggregates. Secondary tillage operations are intended to create fined soil conditions following primary tillage including the operations for formation of seed beds, ridges and furrows.

A tillage tool is defined as an individual soil-working element, such as a plough bottom, a disk blade, or a cultivator shovel. A tillage implement consists of a single tool or a group of tools, together with the associated frame, wheels, control and protection devices, and any other structures and power transmission components.

Priority Areas for Research and Development in Land Preparation:

I. Land clearing and development for agriculture
II. Ploughing
III. Harrowing and Levelling (including precise techniques such as laser levelling)
IV. Bed, Ridge & Furrow formation
V. Bund formation, clearing and plastering in paddy cultivation
VI. Soil Conservation and Improvement
VII. Holing
VIII. Simple agricultural machinery for home gardening purposes

2. Crop Establishment

Establishment of a correct plant population in the field is of prime importance for sustainable crop production. If a proper crop stand is not ensured, much of the expenditure incurred would be wasted. Crop establishment operation includes metering the seeds or placing planting materials and covering the seed with a certain soil mass or an additional mulching layer. Methods and timeliness of sowing greatly influence germination, crop growth, weed growth and ultimately the crop yield. Crop establishment is done by broadcasting, drilling or transplanting. Broadcasting though simple, entails high seed rate and weeding becomes more difficult and expensive. Drilling is an improvement over broadcasting, because the seeds are placed in lines, facilitating inter-cultivation. As the seed rate required for drilling is less, large quantities of seed can be saved in the long run. Transplanting includes picking the plants from the nursery and placing them in the field. These operations may be done manually, semi-automatic or fully automatic.

Priority Areas for Research and Development in Crop Establishment

I. Seeding
II. Planting and Transplanting

3. Crop Management

Crop Management is the collection of agricultural practices used to improve the growth, development, and yield of agricultural crops as well as quality of the harvests. The combination, timing, and sequence of the crop management practices used depend on the biological characteristics of the crop, sowing methods, age of the plants, form of the harvest and the soil, climatic, and weather conditions. The principal crop management practices also vary according to the class of the crop. Irrigation, fertilizer application, pest, disease and weed management, earthening, training of plants and pruning, shade lopping, verification and fumigation are some of the common crop management practices. Presently, high priority is given to the practices reducing the usage of irrigation water and chemicals in crop management stage and improving the effectiveness of fertilizer and chemical applications etc.

Priority Areas for Research and Development in Crop Management

I. Fertilizer application
II. Weed Management
III. Pest and Disease management
IV. Mechanization solutions for wild animal damages
V. Irrigation and Drainage
VI. Training, Pruning and Lopping
VII. Inter-cultivation

4. Harvesting

Harvesting is the process of removal of edible or economically important portion from a crop. Harvesting at correct maturity is prerequisite for maximum yield and ensuring best quality end product. However, identification of maturity level of a crop is comparatively difficult. For instance, maturity of grains is usually defined as the duration in days from seeding to the time when more than 80% of the grains on the panicles are fully ripened. Farmers often harvest their crop at an incorrect stage of maturity which leads to serious quantitative and qualitative losses of the yield. Further, it is also important to harvest the crop without causing physical damages. At present, harvesting operation combines with threshing and cleaning, with the introduction of combined harvesters for various crops.

Priority Areas for Research and Development in Harvesting

I. Development of Harvesting machinery, equipment and technologies
II. Collecting, Loading and Transportation of harvest
III. Improving techniques for minimizing physical damages to the harvest
IV. Development of appropriate equipment for detection of maturity of crops

5. Post-harvesting

The period of post-harvesting begins at the moment of separation of the edible commodity or economically important portion from the plant by a deliberate human act with the intention of sending it to the consumer. The period ends when the produce reached the consumer.

In agriculture, post-harvest handling is the stage of crop production immediately after harvesting which includes processing, drying, cleaning, sorting, packing and transportation. When a crop is removed from the ground, or separated from its parent plant, it begins to deteriorate. Hence, it is important to deliver it to the next step/process without a delay. Post-harvest handling or treatments largely determines final quality, whether a crop is sold for a fresh consumption, or used as an ingredient in a processed food product. Therefore, every effort should be taken to minimize physical damages and contamination during post-harvest handling.

After harvesting the crop, it can be either preserved or processed. Through processes, the value of the commodity can be increased by converting it to different products with the use of conventional or modern techniques (value addition). The storage life of the produce can be extended by processing/preservation.

Priority Areas for Research and Development in Post-harvesting

I. Processing
II. Drying
III. Cleaning and Sorting
IV. Value addition
V. Storage
VI. Handling and Transportation

6. By-products, Residue and Waste Management and Pollution Control

Waste management includes the generation, prevention, characterization, monitoring, treatment, handling, re-use and deposition of solid wastes. There are various kinds of solid wastes including municipal (residential, institutional and commercial, etc.), agricultural, and other (health care, household hazardous wastes, sewage sludge, etc.). The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, environment or aesthetics.

Priority Areas for Research and Development in By-product, Residue and Waste Management and Pollution Control

I. By-products, Residue and Waste utilization
II. Mechanization of compost preparation
III. Recycling
IV. Pollution control

7. Other Priority Areas for Research and Development in Agricultural Mechanization

I. Mechanization needs of protected agriculture
II. Mechanization needs of nursery management and mushroom cultivation
III. Adoption of appropriate technologies (mechanization) available in the foreign & local markets with suitable modifications.
IV. Economics of agricultural mechanization

8. Priority Areas for Mechanization in Livestock, Aquaculture and Fisheries

(Reference: National Research Priorities on Livestock and Poultry 2017-2021 and National Research Priorities on Aquatic Resources 2017-2021, SLCARP)

9. Standardization, Quality Control, Safety and Related Aspects of Agricultural Mechanization

Standardization is one of the main areas of concern in the agricultural mechanization, especially for the farm machinery. Presently, most of the countries are moving towards regional or global standardization system as manufacturing of farm machinery has become a global business. Therefore, it is essential to adhere to regional and global standards with relevant adaptation to the local conditions. Quality control and maintaining of safety related aspects need to be based on the locally accepted standards.

I. Adaptation of regional and/or global farm machinery standards to suit local requirements
II. Quality control of manufacturing processes especially for the small and medium-scale manufactures

10. Recommendations for Policy changes in Human Resource Development and Research and Development

I. Human Resource Development for R&D sections of the institutes on mechanization
II. Allocation of Adequate funds for HRD and R&D
III. Minimizing procedural barriers on utilizing funds allocated for R&D
IV. Introducing government policies to encourage local investment in designing and manufacture of machineries and equipment etc.
V. Introduction of farm machinery as a subject in the curriculum of the higher and vocational education system
VI. Training of farm machinery operators on economical and safer operation of farm machinery and introduction of accreditation procedures

ISBN No: 978-955-9224-62-4

Sri Lanka Council for Agricultural Research Policy
114/9, Wejerama Mawatha
Colombo - 07,
Sri Lanka
Website : www.slcarp.lk, email : slcarp.agri@gmail.com
Tel: (+94)-112697103, Fax : (+94)-112682951