United Nations Asia Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM), Beijing, P.R.China

Technical Advisory Committee Meeting

SUNWAY Hotel, Hanoi, Vietnam

13th – 14th December 2003

Country Report
Sri Lanka

Presented by:

H.M.Tilakaratna,
Deputy Director/ Head
Farm Mechanization Research Centre,
Maha Illuppallama,
Sri Lanka
Tel/Fax: 94 25 2249222
Email: htilakaratna@yahoo.com

Country Report – Sri Lanka

1. INTRODUCTION

In crop production agricultural mechanization becomes indispensable to address problems like drudgery, high production cost, low quality, low cropping intensity and above all the labour scarcity. Various tools in appropriate forms had been used in the history of cultivation of crops. From time to time the necessity had been keeping on changing and today the major concern is on lowering down the production cost, increasing the quality, attracting the young generation towards agriculture and solving the problem of scarcity of labour. During the past, efforts had been made to mechanize various farming operations but the achievements are not at satisfactory level. The task of introducing machines to our farmers had not been easy due to various reasons. Since the importance of use of machinery has now been realized, immediate but well planned, mechanization programmes must be launched in order to achieve sustainability in rice and other field crop production. In this context, the labour intensive and time-consuming operations should be clearly identified and treated first. At the same time increasing the quality of products also should not be neglected.

2. Economic and Social situation

During the past ten years the output of all major economic sectors have shown a considerable increase. The sectoral composition of GDP in the year 2003 consists of Services 65%, Agriculture 18% and manufacturing 16%. Despite rapid advances in the development of technologies and facilities in the agricultural sector, the average level of farm household income remains low compared to other sectors of the economy. In the year 1999, the agricultural sector represented 36.2% of the total labour force and 20.86% of the GNP (Central Bank 2002). Out of 1,800,000 farmer families, nearly 800,000 depend on paddy cultivation for their livelihood. The rice sector accounts for the direct or indirect involvement of 30% of the labour force engaged in agriculture and contributes about 16% to the agricultural income within the country. The rice plays an important role in the nutrition of the average Sri Lankan, as it provides 45% of the calorie and 40% of the protein requirement and constitutes 68% of the total cereal consumption. A recent survey has indicated that 82% of agricultural operators in rural areas depend on more than one income earning activity (DOA).

Still the priorities in mechanization are focused on the rice production as the country is facing a severe labour scarcity mainly because the labour attraction is towards services and other industries. For an annual average population increase of 1.2% and the per capita consumption of 100 kg of rice it is estimated that in the years 2005, 2010 and 2020 averages of 3.23, 3.46 and 3.83 million tons respectively are needed to become self-sufficient. The current national paddy production varies around 2.7 million tons with an average yield of 3.7 t/ha. Therefore, the possible options to reach the goal are to cultivate additional land area of 0.73 ha or to increase the cropping intensity or to increase the land productivity. Increasing additional land area is impossible since we have already reduced our extent of forest more than that should be, in order to ensure undisturbed climatic situation. Both of the other options, increasing the cropping intensity and increasing the land productivity, are almost entirely require the help of suitable machinery.

3. Agro-ecological regions

Of the total land area of the country, nearly one third is used in agriculture while another one third is used in wildlife forestry. The rest is on urban use while a considerable portion has been degraded. On the basis of rainfall, the country has been divided into three major agro-ecological regions: 1. Dry zone (4.17 million hectares) 2. Wet zone (1.54 million hectares) and, 3. Intermediate zone (0.85 million hectares). The dry zone is mainly used for food crop production such as rice, maize, chili and legumes. In contrast, the wet zone is well utilized under perennial plantation crops such as tea, rubber and coconut. The valley areas of wet zone are utilized for growing rice. Intermediate zone is relatively small and agriculture in the highlands is mainly perennials while the lowlands are rice based. Apart from harvesting, the processing processes of

tea, rubber and coconuts are substantially mechanized. However, mechanization of rice and other field crop production still has to go a long way. According to the Central Bank, tea and coconut production in the country increased to new record high levels in 2000. However, in 2001, the output of them including rubber and certain other field crops dropped. The overall growth rate of the agriculture sector decelerated from 4.5% in 1999 to 1.8% in 2000, the lowest since 1996.

4. Farm Mechanization Policies:

The successive governments have adopted different policies as piecemeal solutions with regard to farm mechanization. The major drive was to expand rice production in order to achieve self-sufficiency. While this helped to achieve self-sufficiency objective to a greater extent inevitably it had its cost in terms of loss of efficiency in rice cultivation. The fast reduction of use of animal power that lead for grater hardships on medium and small scale farmers and severe energy scarcity in the field, at national level, is one of the negative outcomes derived from lack of proper policies. In addition, difficulty in promoting local machinery manufacturing industry, uncontrolled dumping of low quality machines and poor financing facilities for purchasing machines by farmers are some of the key areas still have to be looked into.

5. The Farming Systems

The farming systems identified on the source of water used consists of two components. They are irrigated and rain-fed. The irrigated farming systems include paddy and other field crop cultivation in lowlands under gravity irrigation; Upland cultivation under gravity irrigation and upland cultivation with lift irrigation. In contrast, the rain-fed system includes homestead cultivation, 'Chena' cultivation and paddy cultivation.

5.1 Irrigated farming systems:

Tanks, which provide water under gravity irrigation, could be divided into two categories. They are major irrigation feeding 0.25 million ha and minor irrigation feeding 0.28 million ha. (Department of Censes and Statistics). The tanks having more than 80 ha of command area are referred to as major irrigation and the tanks containing a command area of less than 80 ha are known as minor irrigation. Most parts of the dry zone has a network of irrigation system consisting of several village tanks which get water from catchments runoff of the tank situated immediately in the higher elevation and direct rainfall. These minor tanks are found as chains of tanks or cascades. It has been estimated that there are around 10,000 such minor tanks in the dry zone irrigating 100,000 – 120,000 ha of paddy lands (Upasena 1986). The farmers under major irrigations are better secured of water for cultivation than that of under minor irrigation. About 22% of the total land is tank irrigated for two seasons in a year with a cropping intensity less than 1.4 in major irrigation and less than 1 in minor irrigation schemes due to low rainfall, silting and inefficient water management practices (Min.of Agriculture).

The sources of water for upland cultivation with lift irrigation are runoffs of tanks, domestic wells and agricultural wells. Use of ground water for cultivation was a popular method of irrigation in the northern part of the country where surface irrigation was sparsely practiced. As an option to ever-increasing water demand, especially during the Yala season, use of ground water for cultivation was chosen since 1980s. An agricultural well (popularly known as agro-wells) of the size of 6 – 8 m diameter with approximately 9 m depth is sufficient to feed ¼ - 1/2 ha of highland. The estimated number of agro-wells irrigating 15,000 ha of highland throughout the country is 23,623. Initially, the crops were flood irrigated using 2" kerosene burnt centrifugal water pumps. Micro irrigation systems are now being introduced in order to increase the water efficiency.

5.2 Rain fed farming systems:

Rain fed farming systems include the plantation sector (1 million ha), 'Chena' cultivation (1.2 million ha), mixed crop and homestead cultivation (0.6 million ha) and upland paddy cultivation. The uplands that cannot be irrigated with tank water are either used for dwelling or covered with forest. Part of this forest area is used for 'chena' cultivation. The land is cleared by slashing and burning during the dry period, July

and August. This shifting cultivation covers nearly 1.2 million hectare and produce about 80% of rain fed grains (Min. of Agric. 1999). Coarse grains (millets and maize), grain legumes (cowpea, green gram, soy bean and ground nut), condiments (chili and mustard) and vegetables are cultivated on the onset of Maha rains. Highland paddy is grown in some high moisture areas in the lower part of the chena. Crops are grown in mixture. The advantages of this mixed type of cultivation are to minimize the production cost, to produce varieties of food suitable for three meals of the day and above all to avert the risk associated with natural and other hazards. Axe, Ketty, knife and foot protective homemade leather shoe (locally 'Vam Pathul') are used for carrying out slashing and burning operation. Memmoties of different sizes according to the age limits of family members are used for seeding and weeding. A small curved knife for reaping millets and a sickle for reaping paddy. Millet is milled using mortar and pestle while village-level rice mills are available for milling rice. As nearly 0.25 million families depend on chena cultivation for their livelihood it is needed to be considered more settled form of land use assuring sustainability.

Except occasional cultivation of gingerly no other crops are grown during Yala in the rain fed uplands for inadequate soil moisture. Gingerly seeds are broadcast on the unploughed land just after Maha paddy is harvested. The ability of gingerly crops to withstand drought and hence to compete with weeds helps derive a good harvest with minimum production cost. Except sickles for reaping and winnowing fans for grain cleaning, no other tools are used in gingerly cultivation.

6. Farm Power sources:

6.1 Manual power:

Out of 3,800,000 total families, nearly 1,800,000 families are engaged in farming. They provide 2,416,000 labour force for farming activities. Average number of members in a family is five. In general, there is a diminishing trend of employing family labour on farming activities. Excessive drudgery, low income, age-old farming methods and certain social influences are some of the reasons for the present generations to look for other means of living.

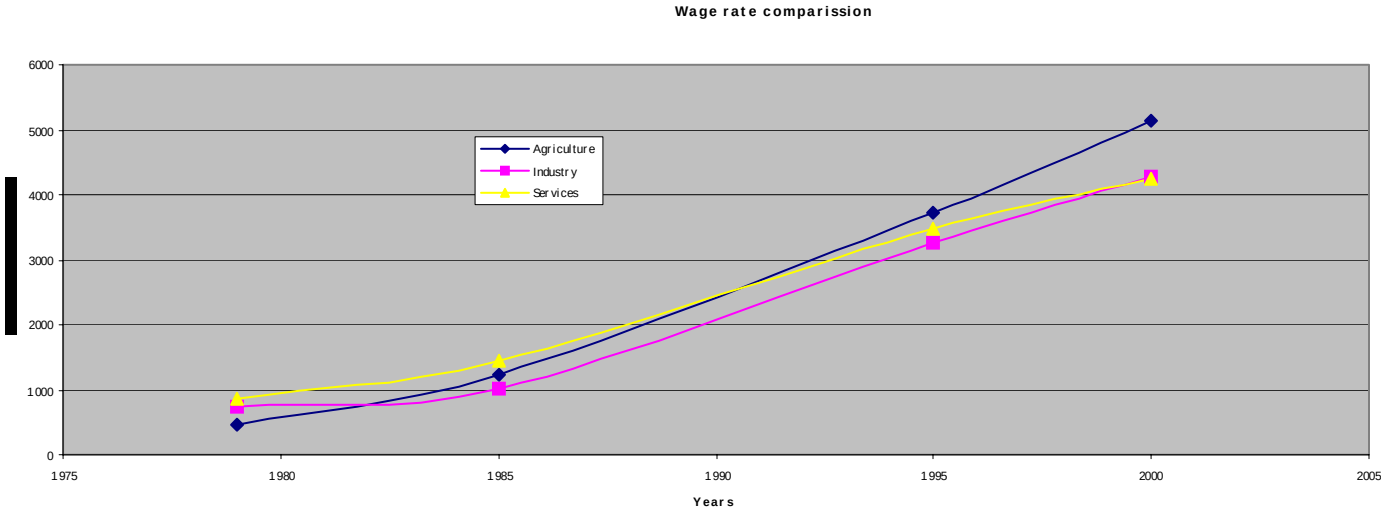
One of the most important variables that decide the successful operations of a farming system is the availability of farm labour and its use (Abeyratne et el. 1986). Within the labour profile, the type of labour is also very important. For heavy operations like land-preparation, clearing bunds and threshing, where male labour plays a major role, its availability within the family or locality helps keeping timeliness that brings several advantages including high yields. Similarly, the operations such as transplanting and reaping carried out by women as equal as men or even more efficiently than men may suffer in the absence of female labour. It is also approximately calculated that a woman-day equals to 0.8 of a man-day. Working continuously, a man produces 0.1 hp and for a short period, he can produce 0.4 hp (FMRC).

Table: Labour wage in rupees in the sectors Agriculture, Industry and Services

Year	Agriculture	Industry	Services
1979	460	723	864
1985	1229	1016	1447
1995	3735	3247	3466
2000	5136	4272	4248

The table and the graphical presentation indicate the escalating behavior of agricultural wage rates. Increased wage means increased cost of production and less labour supply in agriculture resulted in delayed cultivation and severe crop losses. This situation affects the sustainability of emergent farmers and increases farm-gate commodity prices of commercial farms. As far as the hand tools, animal draught and motorized categories of farm power sources are concerned, the hand tools and animal draught that consume high manual power are currently suffered for want of enough labour. It becomes tangible from the fact that gradual reduction in use of manually operated machinery such as seeders, weeders and transplanters. Difficulty in finding skill labour on animal powered operations is also due to limited availability of labour in this field. As shown in the table there is a continuing declining of the draught animal population (from

459,510 in the year 1985 to 262,900 in 2000). Careful introduction of machinery for labour demanding operations such as plant establishment, and harvesting and threshing is the most appropriate way to solve this problem.



6.*2 Animal power*:

In the large-scale paddy growing areas, animal power is used only on final land leveling, before sowing in lowlands. However, in the wet zone animal power is widely used for ploughing, leveling and threshing. One pair of cattle can develop 1 hp and can work 6 hours a day. The economic life of cattle is 6 – 10 years. A pair of buffalo can develop 1 – 1.5 hp but work slowly. The average field capacity of a pair of animals harnessed to indigenous plough is 0.1 ha/day. The buffalo is recognized as an efficient working animal where speed is unimportant. Their economic life is 12 – 13 years. In case of buffalo, both males and females are used as work animals where as only male cattle are used for working. The buffalo has a limited work output under the sun for its low heat tolerance. The cattle population in the country is 1,557,000 and the buffalo population is 693,600 (DCS 2001). However, only 5% of cattle and 24% of buffalo are used for draft purposes (FMRC 2001). These data shows that the total power that could be derived from animals is amounting to 142,965 hp.

6.3 Tractor and engine power:

Apart from the animal powered and hand tool agriculture the so-called mechanization process began in early 1950s with the introduction of twin axle tractors. Basically, the purpose of importation of tractors was to avoid drudgery experienced in land preparatory operation in paddy cultivation and to use as a hauling vehicle in construction industry. Tractors of the hp range 30 – 50 were popular because of the versatility of the usage. The introduction of high yielding paddy varieties was taken place in the mid 1950s and it was felt that the land should be thoroughly prepared, as these new varieties had no ability to compete with weeds when compared to traditional paddy varieties. The dry zone soil that has a low water holding capacity characterized with high shear stress requires high power for inverting and eradication of weeds. Further, the first popular high yielding paddy variety H4 was a hard to thresh type and the traditional animal foot trampling was not efficient enough to separate grains from the panicles. Thus the twin axle tractor, which was gaining popularity for land preparation, was gradually taken over the threshing operation too. The buffalo population in the large-scale paddy growing areas in the dry zone began to decline and a substantial proportion of land preparation and threshing operation came under the hands of tractor owners.
In the early 1970s the single axle tractors fitted with 7 hp diesel engines and 14 blades rotovators were found to be an efficient machine for land preparation of the farmers holding the extents of less than 1 ha. In addition to the low initial investment these small tractors had an attractive fuel economy. In the lowland cultivation the rotovator also could be used for both primary and secondary tillage. Besides, by owning a

single axle tractor the small farmers were able to keep timeliness, as there was no necessity to be in the waiting list to hire twin axle tractors. In the presence of the low maintenance cost, increased leisure time and the great deal of versatility of single axle tractors the use of animal power in the farm became abandoned further. The single axle tractors, especially 12hp riding type, today replace not only the animal power but the twin axle tractors too. The annual input of twin axle tractors to the market is more than 8500 units where as the twin axle tractors are merely few hundreds. The twin axle tractors are also being replaced by tipping type trucks in the process of hauling in the construction industry.
The machinery inventory has a number of 98,000 single axle tractors and 25,000 twin axle tractors providing nearly 700,000 hp and 734,000 hp respectively to the total agricultural power source of the country. This is equalant to 92% of the available power. The tractor power is used for land preparation, irrigation, harvesting, threshing, winnowing and hauling.

6.4 Ownership of machinery and tools

One or two memmoties (hand hoe), Two or three sickles, axes, knives, leveling boards are commonly available with each family. One single axle tractor for 22 families, one twin-axle tractor for 73 families, one sprayer for 07 families and one water pump for 24 families are available.

7. Strength of machinery manufacturing and servicing

Most of the agricultural machinery and equipment needed by the Sri Lankan farmer are manufactured in the country except single axle and twin axle tractors. Both public and private sector manufacturers exist, but the majority of them belong to the private sector. Many large companies manufacturing agricultural tools and machinery are located in the capital city or suburbs. They are usually subsidiaries of groups of companies. There are many medium and small-scale workshops exclusively engaged in production of machinery and tools. These workshops are distributed in the major townships in the country and cater mostly to local and provincial needs. The present strength of manufacturers of each category is as follows:

Number of large-scale manufacturers	- 09
Number of medium scale manufacturers	- 20
Number of small-scale manufacturers	- 40
Number of village artisans	- 1332

The following institutions and establishments are available for the manufacturers to obtain their required designs, prototypes, technical know-how and testing and certification of the machinery.

1. Farm Mechanization research Centre (FMRC), Maha Illuppallama,
2. Institution of Post Harvest Technology (IPHT), Anuradhapura,
3. Farm Mechanization Training Centre (FMTC), Anuradhapura,

There are also instances where individual companies have obtain the designs from their principals abroad as they are the sole agents in Sri Lanka for these machines and equipment. In such cases, assembly or semi manufacture is mostly the arrangement. Apart from this, designs of many hand operated and motor driven village level simple equipment such as water pumps, grain-processing machinery, agricultural tools have reached the country from neighboring India and the Peoples Republic of China. It must however be noted that, in Sri Lanka there is only a limited capacity for local consumption and therefore large investment on assembly line type continuous production systems may not be economically viable. This is the main reason for many manufacturers importing their prime movers.
Agricultural machinery produced locally is mainly fabricated type. Drop forging and steel casting facilities are available with large-scale manufacturers. Except the village artisans, many manufacturers do castings on bronze, aluminium and cast iron. Almost every village boasts of local blacksmiths who forge metal with their primitive methods using hand bellows, charcoal-fired furnace and anvil. The specialized machining techniques such as milling, shaping, boring and lathe work are restricted to the townships. The rural workshops are mainly for repair and maintenance. The other most common facilities available with them include gas & arc welding, drilling and grinding.

Few large-scale manufacturers are capable of investing on R & D work on agricultural machinery. The major cause for this situation is the marginal profit made by the manufacturing industry and seasonal sales of equipment requiring large investment on stocking manufactured goods. The present low or no-tax policy on imported agricultural machinery, although benefits the farmers, has a detrimental effect on the manufacturers. The new industrial policy of the Government encourages local manufacture of machinery with tax holidays, credit and other concessions.

The assembly line type manufacturing schemes are rare due to the limited capacity of the local market. However, some machinery which moves in large numbers are produced this way. These include electrical & engine driven water pumps, power & hand sprayers, vertical reapers and axial flow type threshers.

Sub-contracting of manufacturing items is not common in Sri Lanka. According to the Agricultural Machinery Manufacturers and Suppliers Association (AgMMA), the absence of guarantee on the quality of the parts produced by the small scale manufacturers, limited market share and the marginal profit are the main reasons for the large scale manufacturers to make their own parts and assemble them. In instances where sub-contracting is carried out, it is usually the cast parts which are subcontracted as such a facility needs a large investment. In turn, few companies are specialized on casting of ferrous and non-ferrous materials and have extra production capacity to cater other industries.

Batch production is the most common method of manufacture. The seasonal sale of agricultural machinery, due to the cultivation pattern in the country, leads for such type of production technology.

In order to protect local industry the machinery produced locally are taxed up to 10% at the import while all types of tractors are tax-free. The spare parts are taxed at the rate of 45% of CIF. The second-hand reconditioned tractors are becoming popular imports due to the increasing prices of new ones. The tax imposed at the imports of raw material for local fabrication of machinery is one of the reasons for escalated prices when compared to tax-free imported machinery. The AgMMA pointed out this matter to the National Farm Mechanization Committee (NFMC) and methods are being formulated to refund the tax charged at the occasion where the final product is sent to the market.

Both local and foreign investors have not attempted to make use of the concessions offered by the Government for joint ventures in the agricultural machinery-manufacturing sector. Many reasons could be attributed to this behavior as outlined below.

- The volatile situation in the country during the recent past.
- The difficulty for the locally manufactured goods to compete with low-taxed and better quality imported machines of improved manufacturing technology.
- The limited capacity of the local market and the difficulty in exporting to neighboring countries because of their own protected policies.

7.1 Marketing, Sales, Servicing and Support Services to Agricultural Mechanization

The small-scale manufacturing workshops are generally located in small townships in the form of nucleus of a few villages in the surrounding area. They are mostly owned and managed by individuals. They themselves market their products, mainly in the surrounding areas. The machines sold thus are transported, repaired and serviced by the same manufacturer. Since his sales are limited, he undertakes repairs to agricultural and other machinery.

The large-scale and some of the medium-scale manufacturers have their dealers in the townships. The marketing personnel and service members of these dealers are trained by the parent companies to attend minor repairs. The competent mechanics attached to the manufacturing company do the major repairs.

Most hand tools are either forged or repaired and maintained by the village artisans. The types of equipment usually include mammoties and hoes, ploughs and rotovator blades, knives and sickles, farm carts etc. Artisans themselves sell their items. Many artisans do part-time farming to enhance their income.

Table: Details of Manufacturers

Type of manufacturer	Number in the country	Machinery/Implement/tools produce and sold	Dealer networks	After-sale services done by	Problems encountered
Large-scale	9	Reapers, Threshers, Sprayers, Water pumps, Rice mills, Processing machines, Chopping machines, Electrical motors, Tine tillers for single and twin axle tractors, Cage-wheels	Well organized dealer networks are available	Services and minor repairs by the dealers and major repairs by the company	1.Competition with imported machinery 2. High import tax on row material
Medium-scale	20	Threshers, Transplanters, Seeders, Weeders, Fruit harvesters, Pedal operated pumps, Hand tools, Tractor trailers, Carts, Cage-wheels for single and twin axle tractors, Wheel hubs.	Nearly 5% have dealer networks.	Nearly 5% by dealers and the others by the manufacturer himself.	1.High import tax on row material 2. Lack of capital 3. High rates of interest by the lending institutions 4. Seasonal sales
Small-scale	40	Transplanters, Seeders, Weeders, Fruit Harvesters, Hand tools, Trailers for single axle tractors, Cage wheels for single axle tractors, Wheel barrows	None	By the manufacturer himself	1.High cost of row material 2. Lack of capital 3. High rates of interest by the lending institutions
Village artisans	1332	Hoes, Ploughs and rotovator blades, Mammoties, Farm carts and trailers, Knives, Sickles, axes.	None	Village artisan himself	1. Short supply of row materials 2. Insufficient income

8. Achievements During the Reporting Period

a. Seeding small grains in rows such as Sesame

The need of a sesame seeder was emphasized from southern Sri Lanka and a suitable seeder was designed, fabricated and tested. The well-known 'Johnpulle' seeder principle was adopted in this case. The machine can operate by one person and it has a capacity of nearly two acres a day. Three prototypes have been produced and two of them were issued to Field Crops Research and Development Institute and Oil Grains Research and Development Institute for comments. Seeder also could be used for seeding finger millets.

b. Mechanization of Harvesting and threshing

A separate engine that could not be used for other purposes powers the combine harvesters, available in the market. This makes the investment on the machine high. The machines could be made cheaper if it is manufactured as an attachment to the existing popular two wheel tractors. A small combine harvester attachment was designed and a prototype has been tested. The shortcomings in this system were identified and further modifications were incorporated to the design. The modified version of the attachment is now ready for further testing during the Yala season.

c. Tractor mounted seeder

For large- scale cultivation of maize and pulses the existing highland seeder capacity is not sufficient. Therefore it was decided to couple the manually operated seeder to the existing two- wheel tractor. Preliminary designs were completed and the first prototype was fabricated and tested in the field. Preliminary test shows that it needs reinforcement in certain parts. The required modifications were identified and designs are presently being carried out.

d. Tine Tiller for two- wheel tractor.

The existing mould board plough has low capacity and the required ploughing depth is difficult to be attained. It was also reported that in highland condition the soil inversion leads for loss of residual moisture. To avert this situation a tine tiller consisting of three tines was designed and fabricated. Preliminary test indicated that performance in sandy soil conditions was satisfactory. Testing in the farmer fields was done in the last Maha season and was found satisfactory. Further actions on this matter have been temporarily postponed, as more staff was needed for combine harvester design activities.

e. Research on reduction of chemical weedicides

Research have been conducted on mechanical weeders in order to reduce the application of weedicide that leads for environmental pollution in addition to spending substantial amount of foreign exchange. To facilitate the use of such weeders plant establishment in rows is a necessity and the machines of various kinds for that purpose are now being tried out at FMRC. In this connection the performance of Japanese type transplanter, FMRC manual transplanter and FMRC lowland paddy seeder would be compared.

f. Highland paddy seeding

In order to experiment mechanical weeding of paddy crops cultivated under “kekulan” condition a new seeder was designed and made ready for testing.

g. Adaptation trials at different locations

Following machines have been undergone adaptation trials at different locations in order to ascertain their suitability and performance on different soil conditions, crop sizes and moisture conditions etc.

- Seeder for sesame and finger millets
- Two wheel tractor coupled combine harvester
- Groundnut digger
- Seeder for highland paddy

h. Machinery available for strengthening the extension activities

Sri Lanka being a developing country there is a series of technologies that are in the emerging stage. This is a situation where thorough extension methodologies on industrial and agricultural extension must be adopted. Through the experience at FMRC it is revealed that the manufacturers are reluctant to invest on producing new machinery as they are not sure of whether the farmers would taken up the new technology. On the other hand farmers are doubtful whether they could be able to derive the expected benefits from the new technology. In order to bring this gap closer the extension activities must be further strengthened.

Large-scale agricultural machinery manufacturers produced thousands of sprayers, water pumps, paddy threshers, trailers etc for local market. Many of these manufacturers received FMRC testing and advisory services for their quality improvements. Under the technical assistance from FMRC the local manufacturers produced a series of newly designed machinery. They are 05 high capacity threshers, 30 multi-crop threshers, 345 lowland seeders, 325 cono-weeders, 10 manual operated transplanters and 02

pedal operated threshers. Five local machinery manufacturers were also trained to manufacture FMRC designed machines.

i. Testing of Farm Machinery

As far as the mechanization is concerned the machinery testing and certifying service becomes indispensable in order to achieve the objectives outlined in the policies. The field efficiency, work capacity, durability, availability of uninterrupted after sale services, continuous supply of spare parts and above all the selling price of the machinery are crucial from the farmer's point of view
To confirm the manufacturers specifications the farm machinery testing service carries out laboratory, performance and endurance test comprehensively and issues test reports. Nearly 30% of the machines brought to FMRC for testing had been found to be un-suitable for Sri Lankan conditions.

Following machines were tested during the first eight months of 2004.

- Five four- wheel tractors four form India and one form China
- Eight two wheel tractors two from Vietnam & six from China
- Three sprayer
- One locally made thresher.
- One two wheel tractor coupled reaper

j. Technology transfer activities

Two radio programmes on efficient use of agricultural machinery for paddy and other field crops was conducted. We had opportunities to appear in the Kamatha programme for several occasions and received a very good response from Farmers Island wide. We also actively participated in six exhibitions held in different parts of the country. Newspaper articles on daily and weekly papers were published highlighting the importance of agricultural machinery in reduction of production cost and increase of quality etc.

k. Impact of the Research Programmes

Even though it is difficult to evaluate the impact of machinery on final production etc, in terms of quality and quantity, it is clear that the machinery have their abilities in deriving the following advantages in agriculture.

- Improves timeliness and increases cropping intensity and yield in turn
- Increases quality and quantity increasing the farmer income
- Attracts young generation to choose agriculture as a livelihood
- Makes optimum use of available water

L. Number of Visitors to the Centre

A large number of people visited the Centre for study or training purposes. They included 250 university students, 10 farmers, 30 teachers, 628 school students and 65 Agricultural Instructors. Field level demonstration of various FMRC machines was organized to farmers & teachers.

9. Other Activities:

a. Agricultural Machinery Manufacturers Association (AgMMA)

FMRC attended eight executive committee meetings of Sri Lanka Agricultural Machinery Manufacturers Association (AgMMA) and extended full support for the well being of the manufacturers.

10. Research Programme for the year 2005

For the year 2005 FMRC has planned to carry out the following major activities with regard to Research & Development and Extension work. In addition the Testing of farm machinery, which is a service-oriented activity, will be continued in accordance with the requests from the manufacturers and importers.

a. Testing and improvement of low inversion land preparation technique
b. Development work on motorized weeder for both highland and lowland
c. Development work on two wheel tractor coupled combine harvester
d. Modification on the existing high capacity thresher
e. Design and fabrication of two wheel tractor coupled highland seeder
f. Design and development of tractor drawn groundnut digger
g. Design and development of motor driven groundnut decorticator
h. Design and development of seeder for finger millet

- Promotion of commercial manufacturing and application of Pulses processing machine, Lowland paddy seeder, Multi-crop thresher, Two row highland seeder, Manually operated rice transplanter, Manual weeding equipment for highland and lowland fields, Fruit harvesting devices, Reaper-thresher combination for harvesting and threshing of paddy, Grass mover coupled to two wheel tractor.

10. Institutions Involved in Technology Development

Except for a few private machinery manufacturers the development of the appropriate technology is totally at the hands of Government institutions. A few companies spent a small percentage of their investment on research. The following is the main institutions involved in technology development.

- Farm Mechanization Research Centre (FMRC)
- Institute of Post Harvest Technology (IPHT)
- National Engineering Research and Development Centre (NERDC)
- Private sector manufacturers.

Information on the current mechanization requirement are obtained from the

- Provincial Technical Working Group meetings (PTWG),
- Crop Coordinators Meetings,
- Farmer organizations,
- Private sector companies and
- Individual Farmers.

11. Testing and Certifying

As far as the mechanization is concerned the machinery testing and certifying service becomes indispensable in order to achieve the objectives outlined in the policies. The field efficiency, work capacity, durability, availability of uninterrupted after sale services, continuous supply of spare parts and above all the selling price of the machinery are crucial from the farmers point of view. For unbiased certification the Government involvement is a must. In Sri Lanka only the FMRC has been mandated for testing and issuing certificates on agricultural machinery, both imported and locally produced.

12. Agricultural Machinery Extension

Sri Lanka being a developing country there is a series of technologies that are in the emerging stage. This is a situation where thorough extension methodologies on industrial and agricultural extension must be adopted. Through the experience at FMRC it is revealed that the manufacturers are reluctant to invest on producing new machinery as they are not sure of whether the farmers would taken up the new technology. On the other hand farmers are doubtful whether they could be able to derive the expected benefits from the

new technology. In order to bring this gap closer the following institutions are presently involved in extension activities.

- Farm Mechanization Research Centre (involved in both industrial and agricultural extension)
- Institution of Post Harvest Technology
- National Engineering Research and Development Centre
- Department of Agriculture
- Provincial Departments of Agriculture
- Private sector manufacturers and suppliers.

13. Financing:

This is the weakest point that is appeared in the farm mechanization process. As mentioned in this paper there is a severe power deficiency in the farm. The number of sprayers, water pumps, threshers and combine harvesters available with the farmers are quite insufficient for safe and timely cultivation of crops. Even though the following institutions are there to assist farmers solving the financial problems, it is rather discouraging them because of the number of obstacles that have to be overcome in proceeding with applications.

Financial Institutions

- Government Banks
- Commercial Banks
- Rural Banks
- Samurdhi Banks
- Co-operative Societies
- Finance and Leasing Companies.

14. Country's Farm Mechanization Plans:

The future plans of Farm Mechanization are based on the recently prepared policies by the MA&L to fulfill the following requirements:

- To find solutions to labour scarcity problems
- To increase productivity and quality
- To increase cropping intensity
- To attract younger generation to agriculture
- To increase water efficiency.

15. Successes

Apart from the plantation crops the paddy cultivation is the area that is mechanized most. The following table illustrates the extent of mechanization in relation to different farming operations in paddy cultivation.

Operation	**Percentage Mechanized**
Land preparation	90%
Plant establishment	5%
Pest and disease control	100%
Weeding	2%
Harvesting	15%
Threshing	60%
Combine harvesting	6%

16. Priority Needs of APCEAM members on agricultural machineries, Engineering and emerging agro-technologies (SRI LANKA):

16.1 Strengthening the Agricultural Mechanization Extension Programmes.

Various types of machineries are been produced, but the farmers have known few of them. The main reason for this is the poor extension techniques adopted.

16.2 Conducting demand surveys on machinery needs and manufacturing.

One of the major bottlenecks associated with extension is the lack of statistical data on machinery demand. Updating the database on the actual demand on agricultural machinery for different farming operations is a priority requirement for efficient industrial extension within the Country. A thorough survey must be conducted in this regard from time to time. The manufacturers are reluctant to produce machinery for new technologies since they are doubtful whether they could sell them

16.3 Strengthening the testing capabilities of FMRC

As mentioned above the FMRC is the only Institution in Sri Lanka available for testing and certifying machinery for their suitability in agricultural operations under local conditions. The testing infrastructure and the modern instrument and tools that are needed for accurate and efficient service must be updated.

16.4 Combine harvester for paddy

here is a severe delay in harvesting, threshing and cleaning of paddy crop due to labour scarcity during the peak season. A slight delay leads for heavy field losses owing to over ripening, lodging, insects, rodents and sometimes, unfavorable climate. The solution for this problem is to introduce a combine harvester that could be coupled to single wheel tractors.

16.5 Training for officers and manufacturers on Agricultural Engineering.

Training opportunities are rare on the agricultural engineering and processing technologies in the Country. Short-term training programmes in this regard are recommended.

16.6 Prevention of post harvest losses of vegetables and fruits

It has been estimated that nearly 40% of vegetable and fruits loss before consumption. These occur while harvesting, transporting, keeping in the storage and insect and animal damages.

16.7 Value adding techniques for grains and pulses

A higher price could be fetched if the growers are able to sell their produce in processed form. At present facilities available for this are very few.

16.8 Pressurized irrigation techniques

Efficient usage of water is a key requirement to ensure high land productivity. In this regard the drip and sprinkler irrigation have already proved to be the best methods that must be popularized among the farmers.

169 Engine operated weeding machine

Weeding in the crops is done using chemicals resulting in high cost and in environmental pollution. Hand operated weeding tools did not gain popularity due to law capacity and labour scarcity. A simple engine driven weeding machine, which cost around Rs.30,000 (US $ 300) would be a solution for this.

16.10 Deep ploughing techniques for paddy cultivation:

It is revealed that the yield of paddy has a direct relationship with the depth of ploughing. Deeper the loose soil higher would be the yield. However, since many farmers preferred rotovator coupled single wheel tractors for both primary and secondary tillage the deep ploughing is rarely practiced. On the other hand, in the climatic point of view in tropical conditions, soil loosened without inversion helps prevent soil degradation. Therefore, a tine tiller coupled to two-wheel tractor would be a better solution for this.

16.11 Paddy transplanter

Farmers are aware of the advantages associated with transplanting of paddy over the broadcasting. But, they are unable to practice it for high scarcity of labour. A manual transplanter was introduced some years back but the acceptance was not satisfactory. The main reason for the poor acceptance was the law capacity of the machine. A simple engine operated transplanter having an average capacity of a hectare per day would be a better solution.