CHAPTER II
AGRICULTURAL EQUIPMENTS INDUSTRY IN INDIA

2.1 INTRODUCTION

Agriculture in India is unique in its characteristics, where over 250 different crops are cultivated in its varied agro-climatic regions, unlike 25 to 30 crops grown in many of the developed nations of the world. India with its favorable agro-climatic conditions and rich natural resource base has become the world's largest producer across a range of commodities. India is the largest producer of coconut, mango, banana, milk and dairy products, cashew nuts, pulses, ginger, turmeric and black pepper. It is also the second largest producer of rice, wheat, sugar, cotton, fruits and vegetables.¹

The early agricultural mechanization in India was greatly influenced by the technological developments in England. Horse drawn and steam-tractor-operated equipments were imported during the later part of the nineteenth century. The horse drawn equipments imported from England were not suitable for bullocks and buffaloes being used in India. These were suitably modified to suit Indian draught animals. With the production of indigenous tractors and irrigation pumps, the use of mechanical power in agriculture, has been showing an increasing trend.

2.2 PROGRESS OF FARM MECHANISATION IN INDIA

The progress of agricultural mechanization has been closely linked with the overall development in production agriculture. Till 1950, very few farmers possessed prime movers like tractors, engines and motors. Heavy agricultural tractors and machinery were imported by government organisations mainly for land reclamation and development of large government farms.²
The picture changed quickly during the early sixties with the introduction of high yielding varieties of wheat and other crops which needed irrigation facilities. The rising production of food grains resulting from the extending area under high yielding varieties could not be handled within the normal harvesting and threshing periods. The farmers in North India suffered heavy losses as a result of damage to harvested wheat during the late sixties and early seventies because the threshing of increased wheat production could not be completed before the onset of pre-monsoon rains. Large scale adoption of thresherers operated by electric motors, engines and tractors that followed in early seventies onwards was a result of the need to complete threshing operation quickly. Then came the extensive use of tractors for primary tillage and transport and the use of tractor powered or self-propelled harvesting equipment.  

2.3 PRODUCTION SCENARIO IN INDIA

The productivity of farms depends greatly on the availability and judicious use of farm power by the farmers. Agricultural implements and machines enable the farmers to employ the power judiciously for production purposes. Agricultural machines increase productivity of land and labour by meeting timeliness of farm operations and increase work out-put per unit time. Besides its paramount contribution to the multiple cropping and diversification of agriculture, mechanization also enables efficient utilisation of inputs such as seeds, fertilizers and irrigation water.

The production of irrigation pumps and diesel engines started during 1930s. The manufacture of tractors and power tillers started in 1960. Since then by the virtue of its inherent edge over the conventional means of farming, agricultural mechanization has been gaining popularity. The increased use of farm machines
found expansion of cropped area and cropping intensity and also helped in diversification of agriculture from conventional crops to commercial crops. The manufacture of agricultural machinery in the country is carried out by village artisans, tiny units, small-scale industries and the State Agro-Industrial Development Corporations. Production of tractors, motors, engines and process equipment is the domain of the organized sector.\textsuperscript{4}

The traditional artisans and small-scale industries rely upon own experience; user's feedback and government owned research and development institutions for technological support and operate from their backyards or on road side establishments without regular utility services. Medium and large-scale industries operate in their own premises with sound infrastructure, usually forming a part of an industrial estate, well established manufacturing and marketing facilities and employ skilled manpower.

Diesel engines, electric motors, irrigation pumps, sprayers and dusters, land development machinery, tractors, spare parts, power tillers, post harvest and processing machinery and dairy equipments are produced in this sector. They have professional marketing network of dealers and provide effective after sales service.

They also have in-house research and development facilities or have joint ventures with advanced countries for technology up gradation. India is recognized, the world over, as a leader in the manufacture of agricultural equipment and machinery such as tractors, combine harvesters, plant protection equipment, drip irrigation and micro-sprinkler. Sizeable quantities of farm implements are exported to Africa, Middle East, Asia, South America and other countries.
2.4. MAJOR AGRICULTURAL EQUIPMENTS IN INDIA

With increased cropping intensity, farmers have supplemented or largely replaced animate power with tractors, power tillers, diesel engines and electric motors. The growth in the electro-mechanical power in India is evident from the sale of tractors and power tillers, taken as an indicator of the adoption of the mechanized means of farming. The major agricultural equipments in India are:

2.4.1. Tractors

The different sizes of tractors are manufactured in India ranging from less than 25 HP to more than 45 HP but most popular range is 31-35 HP. The Tractor sales show that their demand is region specific. The Tractor sales show that their demand is region specific.

Punjab, Haryana and western UP constituted the major Tractor market in 1980’s with 55-57% share of total All India sales. With increased Tractor population in these areas and good successive rains in 1990’s, coupled with changes in cropping patterns like adoption of more profitable cash crops (Oilseeds, Pulses, etc.), and better prices, the sales in Gujarat, MP and Rajasthan have been seeing good growth. The contribution of these states improved from 20-22% in early 1990’s to 30-32% by the close of the present decade.

The share of eastern states, namely Bihar, Orissa, West Bengal and Assam had been consistently low at 3-5% due to various socio-economic, agro-climatic and other reasons. The credit availability to the farmers in this area has been another major reason for the slow growth in the eastern states. The tractor sales, since mid 1990’s, have increased to about 10-12% of All India Sales.
Tractor sales in Maharashtra, Tamil Nadu, Karnataka and Andhra Pradesh have been showing consistent growth since mid 1980’s. Their share in the Indian Tractor industry, which was about 14-15% in 1990, had increased to around 25-30% in present decade when the farmers suffered on account of uneven monsoons and poor cotton crops.. This region is expected to contribute more than 35% to the tractor industry in the coming decade. This expectation is based on the fact that the farmers in this southern region have been adopting high value case crops and latest crop production/ management practices.\(^5\)

2.4.2. Power Tillers

The production of power tillers started in 1961 with license to manufacture 12 models. The manufacturers started offering these to framers in various states covering upland and wetland farming conditions. Their introduction coincided with that of agricultural tractors which were more suitable for upland work and provided more comfortable work environment to the operators. The walk-behind power tillers, on the other hand, created dusty environment for the operator.

Secondly, the power tillers in dryland conditions were tiresome which resulted in longer rest periods, and consequently affected the work output. These were also difficult to manage in the hilly situations. The power tiller models being manufactured, and also those being imported from China and being marketed for wetland, stationary and haulage work are being well received by the farmers. The 7 available models have a Drawbar power between 5.3 kW to 10.7 kW.\(^6\)
2.4.3. Seed Bed Preparation Equipment  
Deshi ploughs bakhar and patela were the most popular traditional implements for seed bed preparation prior to 1960’s. Cultivator, disc harrow, mould board plough, puddler, disc harrow-cum-puddler, peg tooth harrow, spring tine harrow, rotavator and patela harrow operated by animal and tractor are the improved implements which have been adopted by farmers. The growth in use of tractor drawn machinery has been in the range of 9-17%. Different sizes of cultivators and disc harrows are used but due to farm road and terrain constraints, cultivators of more than 15 tines and disc harrows of more than 18 discs are not much in use.  

2.4.4. Sowing and Planting Equipment  
The lines sowing not only saves seed but also facilitates regulated application of fertilizer near root zone. Besides, it helps control of weeds through use of mechanical weeders. For precise application of seed and fertilizer, mechanically metered seed drills and seed cum-fertilizer drills operated by animals and tractors have been developed and are being manufactured to suit specific crops and regions Mechanical transplanters for rice and vegetable crops are catching up with farmers. Long handle tools and power weeders for weeding and inter culture and manual and power operated sprayers and dusters for application of chemicals have been commercialised.

2.4.5. Inter- Culture and Plant Protection Equipment  
Weed control in irrigated and rain-fed agriculture during Kharif is a serious problem and the yield is affected to the extent of 20-60 %, if not controlled. Khurpi is the most popular tool used for removal of weeds but it takes 300-700 man-hours to cover one hectare. Use of long handle wheel hoe and peg type weeders, reduce weeding time to 25-110 hours. Bullock operated weeder and cultivator are also used
Introduction

for control of weeds. Different designs of low cost hand operated sprayers and dusters are available for plant protection. Spraying in cotton, paddy, sugarcanes, fruits and vegetables, oilseeds and pulses has become popular. 9

2.4.6. Harvesting and Thrashing Equipment

The harvesting systems prevalent in the country include

(a) Harvesting with sickle followed by threshing with animal trampling.

(b) Harvesting with sickle and manual threshing.

(c) Harvesting with sickle/reaper and threshing with stationary power threshers. Use of reaper harvester is limited due to collection, bundling and transport cost of material and by-products.

(d) Stationary power threshers varying from 5 to 15 hp, operated by diesel engines and electric motors, and tractor to power. The present trend is to use high capacity machines on custom basis.

(e) Combine harvesting.

Sickles are widely used for harvesting. These are easily available at low cost in the villages but their output is low. Self-sharpening serrated sickles of better material and design have been developed. Sickles would continue to be used for various crops by small and marginal farmers, and in hilly regions.

Reapers powered by engines, power tillers and tractors have been developed and introduced for harvesting wheat, paddy, soybean, ragi and mustard. However, because of labour and cost involved in the collection, bundling and transport, their adoption is expected to be limited. Traditionally, threshing of wheat and barley was being done by bullock trampling which is arduous and time consuming. The mechanical threshers of varying power range (5-15 hp) are commercially being
manufactured which not only thresh the grain but also provide good quality Bhusa. Farmers use self-owned threshers or on custom hiring basis. More than 70-80% wheat, barley, gram, soybean, sorghum and pearl millet crops are estimated to be threshed by mechanical power threshers.

Paddy crop is easy to thresh by beating but losses are quite high. Pedal operated paddy threshers reduce drudgery. These have become popular in Eastern India. Raspbar type paddy threshers cause less breakage to paddy stem and, thus, straw can be put to better use. These threshers have become popular in Andhra Pradesh, Tamil Nadu, Karnataka and Kerala. In regions where work force availability is inadequate, harvesting with combine harvesters is in vogue. Combine harvesters are being preferred as they reduce the turn-around time to facilitate increased cropping intensity.

Tractor-powered and self-propelled combine harvesters are being manufactured in India. About 700- 800 combines are sold annually. Track-type Combine harvesters, especially suitable for paddy crop, are also being manufactured locally. The combine harvesting of wheat, paddy and soybean has been well accepted by farmers. Apart from the work force availability problems, the usage of combined harvesters has helped in timely harvesting of grains avoiding losses due to adverse weather conditions. The Tractor Powered Combine Harvesters, costing only 25-30% of the self-propelled combines, may be owned by individual farmers. The self-propelled combines are largely owned by custom-hiring contractors.

The demand of combine harvesters for harvesting wheat crop in Punjab, Haryana and Uttar Pradesh encouraged the local manufacturers to develop local combines. More than 48 manufacturers, mainly in Punjab, produce self-propelled and
tractor operated combines for harvesting wheat, paddy, soybean and gram. The entrepreneurs from Rajasthan and Punjab provide combine harvesting services to the farmers in the states of Maharashtra, Gujarat, Madhya Pradesh, Andhra Pradesh and Tamil Nadu. Most of the combines are suitable for harvesting wheat and paddy. Farmers also use them for gram and soybean. Claas Crop Tiger and Kartar K3500 are the only combines which have been tested by FMTTI, Budni for gram and soybean.¹⁰

2.4.7. Post Harvest Equipment

Agro-processing includes farm-level processing to improve quality of produce and technology for loss prevention in storage, handling and transport. Major equipment which have been developed and adapted for farm level processing include cleaners, graders, dryers, shellers, decorticators and storage structures milling equipment. Cottage and industrial level secondary processing includes, rice mills, grain mills, dal mills, oil mills, preservation and processing of animals, fruits and vegetables etc. to increase shelf life and their quality.¹¹

Today more than 73% of paddy, 55% maize, 24% pulses and 45% oilseeds and 45% sugarcanes are processed by modern machinery besides other commercial crops. The total turnover of food market is approximately Rs. 250000 crores as estimated by Ministry of Food Processing of which value added products comprised of Rs 80000 crores. The total export at present is at about Rs 11000 crores with rice contributing 29% and marine products 42%. The agriculture processing sector has immense employment potential for rural people, provided these activities are undertaken largely in rural areas.
### Types of Agricultural Equipment and their Uses

<table>
<thead>
<tr>
<th>S.No</th>
<th>Name of Agricultural Equipment</th>
<th>Uses</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Ditcher</td>
<td>It is used for making ditches for irrigation and drainage.</td>
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<tr>
<td>2</td>
<td>Tractor Mounted Mouldboard Plough</td>
<td>Ploughs are used for primary tillage operations. It cuts trash and buries it completely. It is also used for turning green manure crop for decaying under the soil, which adds humus to the soil. Compost, farmyard manure or lime when spread in the field, the mould board plough is used for turning and mixing these materials in the soil.</td>
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<tr>
<td>3</td>
<td>Tractor Drawn Disc Plough</td>
<td>Pisc plough is used for primary tillage and is especially useful in hard and dry, trashy, stony or stumpy land conditions and in soil where scouring is a major problem.</td>
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<td>4</td>
<td>Tractor Mounted Disc Harrow</td>
<td>The disc harrow is used for primary and secondary tillage. It is ideal for field disking, especially in orchards, plantations and vineyard. It is suitable for working under trees close to bunds and fence posts.</td>
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<tr>
<td>5</td>
<td>Spring Tyne Cultivator</td>
<td>Cultivators are used for seedbed preparation both in dry and wet soils. It is also used for interculture purpose by adjusting the tynes in wider row crops. It is also used for puddling purposes.</td>
</tr>
<tr>
<td>6</td>
<td>Rotavator</td>
<td>It is suitable for preparing seedbed in a single pass both in dry and wetland conditions. It is also suitable for incorporating straw and green manure in the field.</td>
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<tr>
<td>7</td>
<td>Tractor Bund Former</td>
<td>Making of bunds in the field.</td>
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<tr>
<td>8</td>
<td>Tractor Drawn Ridger</td>
<td>It is used for making furrows and ridges for sugarcane, cotton, potato and other row crops</td>
</tr>
<tr>
<td>9</td>
<td>Power Tiller Drawn Seed Cum Fertilizer Drill</td>
<td>It is used for drilling seeds and fertilizer in six rows.</td>
</tr>
<tr>
<td>10</td>
<td>Self-Propelled Rice Transplanter</td>
<td>It is used for transplanting of mat type rice nursery in the puddle field.</td>
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<tr>
<td></td>
<td>Equipment</td>
<td>Description</td>
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<tr>
<td>11</td>
<td>Sugarcane Cutter Planter, Automatic</td>
<td>It is used for sowing of sugarcane and it cuts the seed setts of desired size in addition to doing other operations of opening the furrows, placing the setts in the furrows, application of fertilizer, treatment of setts and covering of setts simultaneously.</td>
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<tr>
<td>12</td>
<td>Power Tiller</td>
<td>It is for mechanical control of weeds in crops such as tapioca, cotton, sugarcane, maize, tomato and pulses. Attachments like sweep blades, ridger, trailer can be used with the machine. The lightweight power tiller can also be used for tillage under hill agriculture and terrace farming.</td>
</tr>
<tr>
<td>13</td>
<td>Fogging Machine</td>
<td>The fogging machine is used to vaporize pesticides in the form of fog for killing flying insects</td>
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<tr>
<td>14</td>
<td>Aeroblastsprayer</td>
<td>It is useful for spraying on horticultural trees and crops like cotton, sunflower etc</td>
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<tr>
<td>15</td>
<td>Self Propelled Light Weight Boom Sprayer</td>
<td>The self-propelled lightweight boom sprayer is used for chemical application on wheat, vegetable and other crops</td>
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<tr>
<td>16</td>
<td>Tractor Mounted Sprayer</td>
<td>It is used for spraying in vegetable gardens, flower crops, vineyards and for tall field crops like sugarcane, maize, cotton, sorghum, millets etc.</td>
</tr>
<tr>
<td>17</td>
<td>Knapsack Power Sprayer</td>
<td>It is suitable for spraying pesticides and fungicides on rice, fruits and vegetable crops.</td>
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<tr>
<td>18</td>
<td>Self Propelled Combine Harvester</td>
<td>Combines are used for cutting, threshing and cleaning of cereal and other crops in one operation.</td>
</tr>
<tr>
<td>19</td>
<td>Tractor Operated Combine Harvester</td>
<td>Combines are used for cutting, threshing, cleaning and loading in. one operation. It saves 80-90% labour requirement and 33% cost of operation as compared to traditional method.</td>
</tr>
<tr>
<td>20</td>
<td>Portable Rice Thresher</td>
<td>It is used for threshing crops like rice, sorghum, pearl millet and safflower.</td>
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</table>
2.5. FARM MACHINERY INDUSTRIES IN INDIA

The adoption of mechanization technology depends upon the local manufacture and after-sales-services besides credit and financial incentive provided by the Government. The manufacture of agricultural machinery in India is quite complex comprising from village artisans, tiny units, small scale industries to State Agro-Industrial Development Corporations and organised tractor, engine and processing equipment industries.

Traditional hand tools and bullock drawn implements are largely fabricated by village craftsmen and small scale industries. Organized sectors manufacture sophisticated machinery such as tractors, engines, mills and dairying equipment. The small-scale industries seldom have R&D facilities and they depend upon public institutions for technological support. They require not only drawings but also prototypes and technical guidance to manufacture the equipment. These industries however, upgrade the technology with experience.\textsuperscript{12}

2.5.1 Classification of Industries

The classification of industries in India is based on total capital investment (plant and machinery) rather number of workers employed. These are (i) village craftsmen, (ii) cottage industries, (iii) tiny industries, (iv) small scale industries, (v) medium scale industries and (vi) large scale industries. This classification was done to help the small-scale units through incentives and marketing support.

2.5.2. Village Craftsmen

Village artisans are the main source of supply and repair and maintenance of hand tools and traditional implements are made by village craftsmen. These include implements and tools like khurpi, spade, sickle, local ploughs, bakhar, sowing devices, yokes, patela, leveller, oil ghanis, grinding wheels, hand mills, hand operated...
milk churning tools, winnowing devices, sieves, wooden storage structures, bullock carts, manual water lifting devices etc. If village artisans are properly trained they will accelerate the adoption of mechanization inputs due to their proximity with farmers.

2.5.3. Tiny and Small-Scale Industries

The tiny and small scale units fabricate bulk of improved agricultural machinery such as ploughs, cultivators, disc ploughs and harrows, seed drills, planters, plant protection equipment, reaper harvesters, combine harvesters, threshers, cleaners, graders, mills, crushers, oil expellers, diesel engines, irrigation pumps and dairy machinery. Agricultural machines are reserved for small-scale units. There are more than 18000 such units scattered all over the country.

Some of these units also fabricate implements and equipment for tractor and power tiller manufacturers. They may lack good machine tools and heat treatment facilities. Some of them are more organized and have better fabrication tooling’s and thus are able to manufacture better quality machinery. The bulk of the farm machinery is made by the small scale industries. They use materials from mild steel to medium carbon steel. Heat treatment practices are generally inadequate except in few industries manufacturing knife & tillage tools. Equipment manufactured by the SSI units includes Soil working tools, seeding & planting equipment, hand hoes, sprayers & dusters, harvesting & threshing equipment, like reapers, threshers, combines, maize shellers, decorticators, cleaners, graders, mills and oil expellers.

2.5.4. Organised Farm Machinery Industries

The medium scale and large scale industries manufacture diesel engines, electric motors, irrigation pumps, sprayers and dusters, land development machinery, tractors, power tillers, post harvest and processing machinery and dairy equipment. There are 13 tractor, 2 power tiller, 200 diesel engine, 600 irrigation pump, 48
combine and 188 earthmoving machinery manufacturers. The marketing of agricultural machinery by these industries is through their network of dealerships and, therefore, these manufacturers are able to provide effective after-sales service.

These industries upgrade their product and process technologies through their own R&D efforts, in addition to technological support from external agencies. Today, India is recognized as a leading country in the world for the development and manufacture of agricultural implements and equipment. The range of equipment includes, tractors, harvesting and threshing equipment, plant protection machines, irrigation and drainage pumps, sprinkler systems, land development machinery, dairy and agro-processing equipment. India is the exporting increasing volumes of these to various countries including USA, Africa and Asia.12

2.6. STANDARDISATION AND QUALITY

The Bureau of Indian Standards (BIS) with its network of centers and laboratories in the country is mandated to ensure quality manufacture and marketing of agricultural and industrial products in the country. The BIS formulates specifications of agricultural machinery and other appliances and prescribes test codes. The Bureau also issues ISI quality certificate marks to the products which meet technical specification as per BIS standards.

The Government of India has established Farm Machinery Training & Testing Centres for promotion of quality farm machinery. In case of agricultural machinery, requirement of quality certification is limited to the sale of agricultural machinery financed under Government Schemes. On certain items connected with safety and health hazards, it is mandatory to have minimum safety standards built into the design or in the installation of machinery during operation. Threshers, chaff cutters and
sugarcane crushers fall under this category. The agricultural machines manufactured by the organized sector like tractors, earth moving machinery, irrigation equipment, plant protection, dairy equipment, processing machinery etc. are certified for their quality by BIS.\textsuperscript{13}

2.7. TESTING AND EVALUATION

The adoption of agricultural machinery is greatly influenced by the quality and after sales available to the farmers. Since manufacture of agricultural machinery is reserved for small-scale industries, the quality is affected by the manufacturing technology adopted by them. Testing and evaluation helps in up-gradation and quality production of machinery. R&D institutions and quality certification agencies conduct the T&E. Testing and evaluation is conducted on newly developed equipment and during its serial production, to facilitate and ensure quality, reliability, durability, functional ease, comfort in operation and cost of operation. Testing is conducted with well defined standard parameters, defined in BIS, ISO, or OECD standards, and whereas evaluation is done to measure the performance under simulated or field conditions for the parameters for which the equipment has been designed.\textsuperscript{14}

2.8. AGRICULTURAL MACHINERY MARKETING AND AFTER-SALE-SERVICES

The large and medium scale manufacturers have well organised distributors and dealers throughout the country to undertake advertising and product promotion in their respective territories, conduct product awareness training programmes for the prospective customers, provide after-sales-service to the customers including free services, repair and maintenance and supply of parts. Therefore, this organized sector has the whole of the country as their market due to which their production volumes are large, and their information feedback about their product performance,
improvements required in design, production processing or quality, and the new requirements of the farmers to undertake product developments.

Very few small-scale industries have established their marketing network and therefore provide service support in their premises. In the absence of standardization of parts and components farmers are compelled to carry their machines to the manufactures for repair and replacement of parts and components. Due to this, their market size is limited to their proximity, and they are not able to develop their businesses.

The village artisans on the other hand are located in the villages and therefore provide immediate attention to the needs of the farmers in their immediate neighborhoods. Therefore, the tools and implements made by them are against specific requirements of individual customers.

2.9. INFRASTRUCTURE FOR PROMOTION OF AGRICULTURAL EQUIPMENTS

2.9.1. Agricultural Equipment Development and Field Verification

The ICAR is the apex institution for promotion of education, research and extension in the agricultural sector. Besides, Department of Science and Technology and Council for Scientific and Industrial Research (CSIR) also promote development of technology for mechanisation and agro-processing. National Research Development Corporation and Poly-technology Transfer Center under CSIR market technology developed in the country. The District Industries Centers are the nodal department for promotion of village industries and small scale industries. Khadi and village Industries Commission (KVIC) promote and market products produced by cottage industries.
The Indian Council of Agricultural Research for the first time sponsored a scheme to conduct state-wise survey of existing tools and implements used by the farmers in 1954. The results were published in the form of a book entitled “Indigenous Agricultural Implements of India” in 1960s. During the sixties, the ICAR made serious efforts to promote research and development on improved farm implements by establishing 17 Research Training and Testing Centres (RTTCs), one in each major state, which were operated by the State Departments of Agriculture. The major mandate of these RTTCs was to test and modify existing implements and develop new improved implements suitable for different agro-climatic conditions of the country.

During the latter part of the sixties (IV Five Year Plan Period) two Zonal Research and Testing Centres, one at IARI, New Delhi and the other at TNAU, Coimbatore and four research centres at Ludhiana, Pune, Hyderabad and Mandi were established to promote use of improved machinery. Besides, All India Coordinated Research Projects (AICRPs) have been established all over the country under ICAR research system to undertake regional research needs and conduct front-line demonstrations of technology with the cooperation of State Agricultural Universities.

The ICAR also sponsored All India Coordinated Research Project (AICRP) on Energy Requirement in Agriculture in 1970 to study the role of improved machinery in conservation of energy and increasing productivity. The ICAR also sponsored an AICRP on Research & Development of Farm Implements & Machinery, Production of Prototypes and their Evaluation under Different Agro-climatic conditions in 1972 to develop and promote suitable implements for different agro-climatic conditions.
The ICAR established the Central Institute of Agricultural Engineering at Bhopal in 1976 and Central Institute of Post Harvest Engineering and Technology at Ludhiana in 1989 to support R&D, technology transfer and prototype manufacturing activities. The research in the area of farm machinery was further strengthened with the creation of other AICRPs on Power Tiller (1980), Human Engineering and Safety in Agriculture(1994) and a NRC on Reducing Drudgery of Women in Agriculture (1994).

The ICAR has initiated Front Line Demonstrations of Improved Machinery for piloting the technology with the assistance of Department of Agricultural Cooperation of Ministry of Agriculture, Government of India. Receptive farmers are provided implements, service and training to create awareness. Prototype workshops have been established for developing commercial grade machines for pilot introduction.

The ICAR through AICRPs on agricultural machinery conducts demonstrations on farmers field under front line demonstrations (FLD) on newly developed machinery. The ICAR has established 261 Farm Science Centers (Krishi Vigyan Kendras). The proposal is to have at least one KVK in each of the 500 districts. These KVKs are mandated for verification of the technology in addition to providing skill oriented training to the farmers and village artisans.\textsuperscript{15}

2.9.2. Popularisation of Agricultural Machinery

The assimilation of R & D requires an effective technological infrastructure of institutions and services to develop and test prototypes, to set up pilot plants for intensive evaluation and extensive demonstrations besides, training and credit support. New technology also requires network for transfer of technology to the manufactures. Popularisation of agricultural machinery in the country is undertaken by the Provincial Governments through Department of Agriculture or Department of
Agricultural Engineering. The activities are coordinated by the Department of Agriculture in Cooperation with the Ministry of Agriculture, Government of India. The Ministry of Food Processing promotes technology related to agro-processing.

The extension system deals with the first-line extension projects with a view to: (i) demonstrating the latest technologies to the farmers as well as the extension agencies; (ii) testing and verifying the technologies on the farmers field (iii) providing opportunities to get firsthand scientific feedback; (iv) developing extension or technological models for the state extension systems; (v) providing training and communication support; and (vi) promoting research in transfer of technologies.\textsuperscript{16}

2.10. CENTRAL SECTOR EXTENSION PROGRAMMES

2.10.1. Promotion of Agricultural Mechanization

For this programme a plan outlay of Rs. 340 million has been made during VIII plan. In this scheme, subsidy for the purchase of tractors below 18 pto hp along with 3 matching implements is being provided to farmers, individually or in a group, having irrigated land between 2.4 to 3.2 ha. Subsidy rate is 30\% of the cost to a maximum limit of Rs. 30000. This programme has been slightly modified during 1996-97 by enhancing the plan outlay from Rs. 340 million to 450 million and enhancing the scope of tractors to be included from 18 pto hp to fuel efficient tractors fitted with engines not exceeding 1800 cc (tractors in the range of 15-30 hp). With the revised outlay of Rs.450 million it would cover subsidy for 15000 tractors and matching implements.
2.10.2. Special Food Production Programmes (for Wheat, Maize and Millet)

Under these programmes subsidy is provided up to 50% of the cost limited to Rs. 1500/- per implement/farm on bullock drawn implements. Under maize and millet programmes, subsidy is also provided on plant protection equipment limited to 50% of cost or up to Rs.600/-.  

2.10.3. Oil Seed Production Programme

Under this programme subsidy is being provided on bullock drawn implements to the tune of 50% limited to a maximum of Rs.700/- to small and marginal farmers. Subsidy is also being provided on plant protection equipment up to 50% of cost limited to Rs.500/-

2.10.4. National Pulse Development Programme

Under this programme subsidy is being provided on bullock drawn implements up to 50% of cost limited to Rs.500/-per farmer. Subsidy is also provided on plant protection equipment up to 50% of cost limited to Rs. 500 and Dal processing equipment up to 50% of cost limited to Rs. 4000 for machines of less than 1.5 hp capacity.

2.10.5. Intensive Cotton Development Programme

Under this programme subsidy is being provided on plant protection equipment up to 50% of cost limited to Rs.600 for manually operated equipment and 25% of cost limited to Rs. 4000 for tractor mounted equipment.

2.10.6. Integrated Programme for Rice Development

Under this programme subsidy is being provided on animal drawn implements, rice transplanter and water pumps up to 50% of cost limited to Rs.1500. Subsidy is also being provided on power tillers up to 25% of cost limited to Rs.12000.
2.10.7. Development of Industrial Designs of Prototypes of Implements

This scheme was approved for the 8th plan with an outlay of Rs.13.5 million. The scheme envisages identification of improved, nearly developed equipment and grant of financial assistance to the R&D institutions for developing industrial designs together with jigs and fixtures needed for their commercialisation.17

2.11. STATE SECTOR EXTENSION PROGRAMMES

Under the state sector programmes generally two promotional programmes are being perused by the state governments;18

2.11.1. Custom Hiring of Implements

Under this programmes tractors with matching implements for deep ploughing, rotavation, reapers, threshers, combines, drilling and boring machines, dozers and ditchers are being given to farmers on subsidized hire charges.

2.11.2. Manufacture of Implements

State governments having agricultural implement workshops are manufacturing a good number of improved agricultural implements and providing to farmers at nominal profits. Most of the implement popularisation Schemes sponsored by the Central Government are under review to have an integrated approach to the input requirements of the farmers. Under Macro Subsidy Schemes, the State Governments are required to prepare a consolidated requirement based on the inputs to be promoted for increasing the productivity of agriculture.

2.12. CREDIT AND FINANCIAL INCENTIVES

The purchasing power of the farmers is low. The government provides subsidy and credit at reduced rate to the farmers who are economically and socially at disadvantageous position to adopt modern technologies. The long-term credit are
usually availed for the purchase of mechanisation inputs and short term for the purchase of seed, and fertilizer. This is one of the indicators of progressive attitude of farmers. The agricultural machines and tractors are purchased through credit, available from organized financial institutions.

NABARD is the main refinancing institution. The Government also provides incentives to farmers for modernisation of agriculture. This is linked to crop specific programmes operated by state governments. Some of the states could not avail the advantages in the absence of adequate infrastructure for promotion of agricultural engineering programmes. The state government may have to strengthen their extension machinery for providing incentives to the farmers. Draft Agricultural Policy resolution emphasised special consideration for input support to poor farmers with fragmented land holdings and those in eastern, hilly regions, rainfed and drought prone areas.

The financial requirement for the purchase of agricultural machinery has increased considerably. The commercial and Cooperative Banks provide credit for the purchase of machinery. The medium and long-term loans are usually disbursed for the purchase of machinery. To simplify the credit and other financial incentives “Farmers Agri-Credit Card” facility is being introduced in few states to facilitate easy availability of credit including fiscal incentives. Farmers prefer to invest their own money for the purchase of hand tools and bullock drawn machinery and for others they avail the credits from the banks.19

2.13. FUTURE THRUSTS IN AGRICULTURAL MECHANISATION

India is a large country with wide-agro ecological diversity having predominance of rainfed agriculture, with irrigated agriculture limited to 34% only.
Farm holdings are small due to higher population density and land fragmentation will continue due to ‘Laws of Inheritance’ and ‘Hindu Succession Act’. Majority of the farmers have limited surplus money to modernize farms or to invest in improved inputs. Draught animals and increasing agricultural workers population may remain to be the major source of farm power for soil manipulation and for crop handling, particularly in Hill and Mountain regions. Mechanical power for tillage, irrigation, harvesting and threshing will be preferred, including on custom hiring basis.

As a result of GATT agreement, prospects of agro-export are likely to increase and product quality standards stipulated under WTO would encourage more and more farmers to adopt modern agricultural production technologies. The future agricultural mechanization technology package therefore may have to;

- Be eco-friendly utilizing land water and bio resource catering to the varied group of farm holders
- Facilitate farming operations which are arduous and hazardous
- Increase productivity and conserve resources through effective utilization of chemical, biological and mechanical inputs, and
- Modernise commercial agriculture to facilitate agro-export.

Keeping above objectives, the mechanization policy may have to be distinctly different to serve hill agriculture, low lying water logged soils, rainfed and irrigated lands and regions having agro export potential.\textsuperscript{20}

2.13.1. Hand Tool/Machines

Hand tools for handling of soil, improved sickle, weeder, sprayer, duster, sheller, and decorticator are being manufactured by unorganised and organised sector and these are being used within the means and resources of the farmers. The quality of
these equipment will further improve as demand picks up and general quality consciousness increases amongst farmers. Tools for horticulture and forestry will have growing demand. The present gap in their availability could attract manufacturers to import these. This would prompt manufacture of better design and better quality tools in India.

2.13.2 Animal Operated Machines

Use of mechanical power is increasing but draught animal power will continue to be in use for many years to come. These draught animals will continue to be utilised for tillage, sowing, inter culture and transport. The present available designs of farm machines for these operations are adequate but will require refinement in quality through material substitution and better manufacturing processes. For the manufacture of critical parts and components in large volumes, the role of organised sector should be encouraged to adopt the village craftsmen and small scale industries in order to help them in the assembly and production of good quality agricultural machinery.

2.14. TRACTORS, POWER TILLERS, DIESEL ENGINES AND OTHER AGRI-MACHINERY

2.14.1. Tractors

The present tractor industry is capable of meeting domestic requirements with 10-12% annual growth leading to stabilization at around 7-8%. The export of tractors, showing growth trends, is going to increase particularly in Africa, and many Asian and CIS countries. The tractor manufacturers are aware of these possibilities and some of them have already taken steps to make their products more export worthy through their own R&D and joint ventures. This will not only help export but also Indian farmers.
The latest package of computer integrated flexible manufacturing system will not only be economical but also provide better industrial environment. The present tractor use is limited to tillage, transport and stationary operations and, thus has a lower annual utilisation. In future, use of tractors will extend from primary to secondary operations like sowing, spraying, inter culture, harvesting, agro-forestry, tree harvesting, plantation, land development, excavation for drainage, mulching and drilling. These will require introduction of specialised tractors.

### 2.14.2. Power Tillers

Demand has not picked up in the country due to availability alternative power sources. For mechanisation of hill agriculture and orchards, light weight power tillers with matching equipment for different farm operations would be required. The present designs may not suit this requirement and, therefore, more suitable designs, including imported machines, should be introduced with adequate incentives and credit support to popularise their use.

### 2.14.3. Irrigation Equipment

Demand for irrigation equipment including drip and sprinkler is increasing, particularly in water deficit regions. The drip system is likely to increase for application of chemicals and fertilisers. The pumps are operated by electric motors or diesel engines. While quality of electric motors is satisfactory, the farmers continue to use horizontal and vertical type diesel engine operated pumps. These engines, though cheap, have higher operational costs due to poor quality and life, and high fuel consumption. Efficient lightweight diesel engines have to be developed, manufactured and promoted. Solar photovoltaic pumps and wind mill pumps have potential especially for drip irrigation systems.
2.14.4. Power Operated Agricultural Machinery

Machines for primary and secondary tillage operations, of varying quality, are commercially available to meet the farmers’ needs. In the absence of quality promotion measures, the quality of these machines is rather poor. A policy should be devised to promote the manufacture of these machines conforming to BIS specifications, and their sales subject to BIS quality certification. Till such time, the manufacturers have to be encouraged to manufacture these machines by adopting BIS certified components.

Several designs of sowing and planting machinery have been developed and commercialized. The utility of these machines in rainfed agriculture has been amply demonstrated. The R&D Institutions and BIS should work together to screen the designs for their standardisation to promote manufacture of good quality implements.

2.14.5. Machines for Transplanting/Planting

Transplanting of paddy, sugarcane, vegetables and trees are yet to be developed to an acceptable level before these are taken up for commercial production and adopted by farmers. This should be taken up on priority by R&D Institutions and industries. Initial importation may accelerate the pace of development.

2.14.6. Machines for Application of Manure and Liquid Nitrogenous Fertilisers

Equipment for application of manure and liquid fertilisers are not available in India. Handling and application of biogas slurry is also manual. These require special attention of R & D Institutions.

2.14.7. Plant Protection Equipment

Plant protection manufacturing industry is fairly well organised. Hand and power operated machines are manufactured by large number of industries some of which have obtained ISI certifications. Machines for tall crops and trees including
ULV and electrostatic sprayers are yet to be taken up for manufactured by the industries. The development of horticulture sector is likely to increase the demand of such sprayers.

2.14.8. Reaper Harvesters
The power tiller and. Self-propelled reapers and reaper attachments for power tillers can provide an economical alternative for those farmers who can not afford the combine harvesters due to economic and land topography reasons. The pace of development and adoption of reaper is slow which needs to be accelerated.

2.14.9. Combine Harvesting and Other Harvesting Equipment
Combine harvesting is in vogue in some States and the industry is capable of meeting the present demand. The combine harvesting at present is limited to cereal crops only. However, most of the straw is left in the fields and burned. Alternative straw handling and disposal technology may have to be developed and promoted as burning of straw is creating environmental pollution and farmers are loosing valuable animal feed material. Maize, sorghum, cotton, sugarcane, potato, peanut, sunflower, safflower, soybean and pulses are predominantly harvested manually.

2.14.10. Threshers
Threshing technology is well accepted by the farmers. The demand for cheep threshers led to design of thresher with inadequate safety measures resulting in to a large number of fatal accidents. Since, the agricultural machines are manufactured by unorganized sector; the enforcement of the act has been difficult. A policy decision should be taken to make it mandatory to display the source of their origin for ensuring adherence of minimum safety standards by the manufacturers.
2.14.11. Specialized Farm Machinery

Machines for land development, excavation for drainage channels, mulching, trench cutting and post hole digging are not commonly available. Fodder production, tree felling, pruning etc. are performed manually. In the absence of machines for such operations, even an assessment of their requirement is difficult. Limited introduction through importation may help in projecting their need and the likely future demand. Green house technology is increasingly becoming popular in some States for horticulture and floriculture. Implements and equipment is required for the management of crop production in green houses.\(^{21}\)


3. www.indiaitaly.com

4. www.ibef.org


18. Ibid., 2009.


20. www.unapcaem.org

21. www.agricoop.nic.in