CHAPTER 12

FORMULATION AND IMPLEMENTATION OF AGRICULTURAL MECHANIZATION STRATEGIES IN INDIA

by

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INTRODUCTION

India has experienced spectacular development in agriculture since she launched her first five year plan in 1951 e.g. food grains production has increased from a level of 53 million tonnes in 1951/52 to 173 tonnes in 1989-90. This has been possible as a consequence of the progressive policies of the government to promote R & D and education; investments in production facilities for agricultural inputs, and industrial goods; rural extension services; rural credit lines, etc. The farmers, on one hand, and trade and industry, on the other hand, have played an equally complementary role in this direction. The agricultural sector provides food to the growing population; employment for 75 per cent of the population; raw materials for industrial production; foreign exchange through agricultural exports, investible surpluses to the pool of domestic savings and a vast market for domestic manufactured products. The most important feature of Indian agriculture has been that the benefits of the green revolution have not been monopolised by the big farmers alone but these have permeated down to all categories of farmers. Even costly machinery like tractors, threshers, etc, which are directly related to the economies of scale, are available to the small farmers. The landless farm labourers and farm women have also gained from the utilization of the new technologies, in terms of higher and better health through cheaper food and reduction in drudgery in performing the arduous farming tasks. The agricultural mechanization inputs wherever adopted, have helped in, among other areas in: increasing production; attaining higher levels of productivity; increasing rates of economic returns; reducing the risk of pre harvest and post harvest crop losses; increasing employment opportunities for skilled, semi-skilled and unskilled labour and in reducing the drudgery of field tasks and and overall improvement in the working environment. This has been possible because of improvements in timeliness of operations; precision of operations; and increment in rate of work. Our main objective in this paper is to highlight the main developments and achievements in the field of agricultural mechanization which India has achieved over the past 50 or so years.

INDIAN AGRICULTURE

In order to appreciate the initiatives and current programmes in mechanization, a brief introduction of agriculture in India is necessary. India has diverse soil and climatic conditions comprising of 15 broad agro-climatic zones and various agricultural crops can be grown. The total area of the country is about 329 million ha while the total net sown area is about 149 million ha. The population in 1990 is estimated at 811 million which is projected to increase to between 945 and 995 million by 1995. About two-thirds of the present population is dependent upon agriculture, out of which 41.6% of total population being cultivators (i.e. those who own their own farm or lease land) and 24.9% being agricultural labourers (i.e. those who are solely employed in agriculture). The total rural population is 76.7 per cent. The female sex ratio of the country is 933 per 1000 males. The literacy in male and female is 47 and 25 per cent respectively. The climate is broadly described as tropical monsoon type. The average rainfall is about 1170mm. The total annual precipitation is estimated to be 400 million ha of water. The annual rainfall, however, fluctuates from region to region both in space and time. On the basis of rainfall, the country can be divided into 3 broad zones:

(a) Dry (below 750mm) : 30 per cent of land area

(b) Medium (750-1150mm) : 42 per cent of land area

(c) High (1150mm and above) : 28 per cent of land area.

About 75 percent of the annual rainfall is received from June-September, with south-west monsoon phenomenon, while the post and pre-monsoon rainfall accounts for 10-11 per cent each, the rest 3-4 per cent are winter rains.

Soils & Land Tenure

The soils of India are normally categorised into 13 types. Alluvial soils occupy 43 per cent of total area followed by black soils (13.7 per cent) and red (sandy and loamy) soils (10.2 per cent). Thus, two-thirds of the total area of the country is under these three soils. Laterite and desert soils occupy almost one-sixth of the area of the country. Alluvial soils are one of the most important soils in terms of economic importance. In the pre, as well as, post independence period, India experienced remarkable change in the nature and extent of tenancy. After independence, radical land reform measures were introduced in the country. These legislations, inspite of numerous difficulties in their implementation, have resulted in substantial decrease in tenancy and significant increase in self ownership. According to 1985-86 agricultural census, marginal farmers operating less than one hectare of land constituted about 58.1% of total number of

operational holdings but the area cultivated by them was only 13.2% of total cultivated land. The medium and semi-medium farms (between two and ten ha) form the most important group of operational holdings. The details of operational holdings are given in Table - 43.

Cropping Pattern

During the past three and a half decades, the cropping pattern has undergone a tremendous change. To start with, the process of change was set in motion in 1950s and early 1960s. It gained momentum with the expansion of irrigation facilities and the advent of High Yielding Varieties (HYVs) of wheat in late 1960s and of rice in 1970s. The percentage of area under some important crops to gross cropped area is shown in Table - 44.

TABLE 43 - Distribution of land holdings (1985-86)

No. of holdings: x 10^3
Area : x 10^3 ha

Category of holding	No of operational holdings - 10^3 (% of total No. of holdings)	Area cultivated x 10^3 ha (% of total area)
Marginal (less than 1 ha)	56,748 (58.1%)	21,606 (13.2%)
Small (1 to 2 ha)	17,881 (18.3%)	25,533 (15.6%)
Semi medium (2 to 4 ha)	13,253 (13.5%)	36,579 (22.3%)
Medium (4 to 10 ha)	7,920 (8.1%)	47,008 (28.7%)
Large (10 ha & above)	1,929 (2.0%)	33,187 (20.2%)

Seeds

The HYVs of wheat and rice have made greatest impact on cereal production. The progress made in coverage of areas under wheat, rice and maize HYVs is indicated in Table - 45.

TABLE 44 - Cropping Pattern

% land sawn to crops (1986-87)

Crop	1986-87	Crop	1986-87
Rice	23.2	Sugarcane	1.8
Wheat	13.1	Cotton	3.9
Maize	3.4	Jute	0.5
Barley	0.7	Tobacco	0.2
Pulses	13.2	Potato	0.5
Oil	10.4	Onions	0.1

TABLE 45 - Area under High Yielding Varieties (HYVs)

Crop	1960-61	1970-71	1980-81	1985-86	1988-89
		(Area x million ha)			
Rice	0.89	5.59	18.23	23.47	29.0
Wheat	0.54	6.48	16.10	19.08	22.0
Maize	0.21	0.46	1.60	1.80	2.50

The country has a seed act which specifies that no person can sell the seeds of notified kind/varieties unless such seed meets minimum standards of germination and purity.

Fertilizers

The use of chemical fertilizers in the country has also increased significantly. After the introduction of HYVs, the use of phosphatic fertilizers and micro nutrients have increased tremendously. The fertilizers consumption in the country during the period 1951-89 is given in Table - 46. About 80% of fertilizer consumption is used in irrigated areas. There is wide inter-state variation in fertilizer consumption ranging from 160 kg/ha (in Punjab) to about 5 kg/ha (in Assam). There are 45 fertilizer testing laboratories with an analyzing capacity of 74000 samples per annum and 454 soil testing laboratories with analyzing capacity of 6.4 million samples per annum.

TABLE 46 - Consumption of chemical fertilizers

('000 Tonnes)

Year	N	P_2O_5	K_2O	Total
1951-52	58.7	6.9	-	63.6
1955-56	107.5	13.0	10.3	130.8
1960-61	210.0	53.1	29.0	292.1
1968-69	1208.6	382.1	170.0	1760.7
1973-74	1829.0	649.7	359.8	2838.6
1978-79	3419.5	1106.0	591.5	5116.9
1983-84	5204.4	1730.3	775.4	7710.4
1988-89	7246.1	2721.6	1068.2	11035.9

Pesticides

The consumption of pesticides has gone up mainly due to increased use of HYVs as well as multi-cropping system and also increase in the irrigated area under cultivation. The pesticides consumption in the country is given in Table - 47

TABLE 47 - Consumption of Technical Grade Pesticides:

('000 Tonnes)

Year	Consumption
1950-51	2.35
1960-61	8.62
1970-71	24.32
1980-81	45.0
1985-86	52.0
1988-89	84.67

Irrigation

While the river systems irrigate the whole country, tanks and wells have traditionally served areas which are in the drier parts of the country, wells and tube wells are mainly found in the alluvial plain and nurture the largest area under irrigation in the country. Net areas irrigated by different systems is given in Table - 48. The most significant development in irrigation is the increase in the contribution made by the tube wells and pump sets. Assured irrigation from these sources has contributed greatly to the phenomenal increase in productivity and output. The present population of irrigation pumps and their annual production is estimated to be 10.5 million and 0.6 million units respectively.

TABLE 48 - Area irrigated by different systems

(Area x 10^3 ha)

Source	1950-51	1960-61	1970-71	1984-85
Government Canals	7158	9170	11972	12933
Private canals	1137	1200	866	858
Tanks	3613	4561	4112	3972
Tube wells	NA	135	4461	5843
Other wells	5978	7155	7426	7601
TOTALS	**17886**	**22221**	**28837**	**31207**

Electrification

Since independence, power has been given a very high priority in the planning process. In fact, highest proportion of plan expenditure has been incurred on power, followed by irrigation. Table - 49 shows the growth of electric power consumed in the country.

Table 49 - Electric Power Consumption

(in million kwh)

Year	For agricultural consumption	Total consumption	% share of agricultural consumption of total
1980-81	14489	82367	17.59
1981-82	15201	90245	16.84
1982-83	17817	95589	18.64
1983-84	18234	102344	17.81
1984-85	20960	114068	18.40
1985-86	23422	122999	19.10
1986-87	28218	136081	20.74
1987-88	34814	146206	23.81

Yields

Table - 50 gives the yield per hectare of principal crops. All India rice yield is

1688 kg/ha. Average rice yield in Punjab (which has highest degree of mechanisation) is 3082 kg/ha. This shows that the country has still a long way to go to enhance average yields on an all India basis. Mechanization can play a very important role in this regard.

Horticulture

The area under fruits in 1986-87 was around 2.94 million ha and under vegetables 4.31 million ha. The use of machines in horticulture is much lower. The fruit and vegetable production during 1988-89 was estimated to be around 25.5 and 50 million tonnes respectively indicating a low productivity in this area.

Table 50: Average yield of principal crops

Crop	1950-51	1960-61	1970-71	1980-81	1988-89	
Rice	711	1013	1123	1336	1688	
Wheat	663	851	1307	1630	2241	
Maize	547	926	1279	1159	1401	
Pulses	441	539	524	473	589	
Oil Seeds		481	507	579	532	827

Market Support

The role of co-operatives in the marketing of agricultural produce has been progressively expanding and this has helped farmers to obtain better prices for their produce. As an integral part of the strategy to increase agricultural production, the Central Government announces every year support prices in respect of wheat, rice, coarse grains, pulses and oil seeds. For agricultural commodities like potatoes, onions, ginger, etc, market support is provided through declaration of market intervention prices.

Plasticulture

The use of plastics is crucial to Indian agriculture in view of the changing technological scenario for boosting crop yields and productivity. The consumption of plastic was a bare 5000 tonnes in 1959. It has now touched 500,000 tonnes and within a few years it is expected to reach a million tonnes. The greenhouse/low tunnels, mulching and nutrient film technology are at an advanced stage of development. Plastic films for lining of canals and farm ponds, sprinkler/drip

irrigation and packaging of fruits and vegetables have achieved a fair level of adoption.

REVIEW OF INDIAN AGRIC MECHANIZATION PROGRAMMES

Five Year Plans

With the expansion of irrigation facilities, introduction of high yielding and short duration varieties of crops, fertilizers and plant protection requisites becoming increasingly available, a base for intensive farming in the country was created. The emphasis during the first plan (1951-1956) and second plan (1956-61) was on introduction of improved manually operated and animal drawn implements and tools. This trend continued to be in evidence during the third plan (1961-66) as well. It was naturally difficult to embark on programmes of popularisation of power operated machinery in the absence of indigenous production and for lack of well tested equipment. The demand for such power operated machinery (tractors, power tillers, etc) was met through importation. The popularisation of improved implements such as mould board plough, cultivators, chaff cutters, winnowers, etc, nevertheless contributed towards modernisation of farming techniques.

Towards the end of the second plan, of indigenous agricultural implements were conducted, and research centres for development of new and improved implements were set up, and a system for production and distribution of such implements and organisation of training facilities for artisans engaged in the manufacture of improved tools was created. The imperative need of a purposeful and large scale farm mechanisation programme, however, came to be realised during the Third Plan and this was in a large extent due to the recognition of the importance of farming practices based on technological devices. It came to be appreciated that along with the inputs like seeds, chemical fertilizers, pesticides, etc, supply of farm machinery and improved implements must also be organised. Steps were taken to develop indigenous capacity for manufacture of agricultural machinery and it was realised that farmers must be supplied with credit for acquisition of such farm machinery. During the third plan, sixteen research, testing and training centres were set up. At these centres work on development of new and improved implements and research on agro-implement-practices and management was initiated. Facilities for training of village artisans on the repair and production of improved implements were organised by setting up 46 workshop wings attached to Extension Workers' Training Centres. Centres were also established for training of farmers and extension workers in the operation and maintenance of tractors and agricultural machinery. One of the centres later developed into a testing laboratory for testing and evaluation of tractors, power

tillers and other power machinery. The centre was modelled on the lines of the National Institute of Agricultural Engineering at Silsoe U.K. Another significant step taken was the exemption of wheeled tractors and power tillers from the licensing provisions of the Industries Act which enabled intending manufacturers to enter the market. Government also liberalised the allocation of foreign exchange for importation of capital goods in favour of agricultural machinery industries.

The Government promoted the establishment of State Agro Industries Corporations in 17 major states with a view of making available services of costly machines to small farmers, manufacturing of improved implements and tools developed by research institutions, assisting in the efficient distribution of inputs like seeds, fertilizers and pesticides and, promotion of agro-based industries having a bearing on production, preservation and supply of foods. These corporations were Government owned companies and they undertook various activities in the farm machinery area, important among which were hire-purchase-sales of agricultural machinery, assembly-distribution and after-sales-service of imported tractors and custom agricultural services.

By the end of fourth plan (1969-74) the above measures yielded results and total availability of farm machinery increased substantially. In the fifth plan (1974-79) a special programme of introduction of improved implements for rice cultivation and a programme of trials and installation of hydraulic rams was initiated. However, the size of programmes was not adequate. Under the scheme of training and financial assistance to unemployed engineers for setting up Agro Service Centres, and for technical services for machinery hiring, etc, about 3000 agro service centres were set up in different parts of the country. However these centres faced a number of problems and it was subsequently established that custom hiring centres alone were not economically viable. During the sixth plan (1980-85) and seventh plan (1985-90), a large programme of demonstration and subsidised sale of improved implements and hand tools for small and tribal farmers was undertaken under which 82900 demonstrations were organised on farmers' fields to educate them about the benefits and economics of using the improved tools and on operation, adjustment and care aspects. In addition about 500000 improved tools were also supplied to small and tribal farmers at subsidised prices.

Two committees were set up by the Government to advise on various aspects of popularization of agricultural machinery. The Agricultural Implements and Machinery Review and Release Committee with responsibility of taking stock of technological developments and recommending suitable implements for different agro-climatic regions was constituted. A non-statutory Central Agricultural Implements and Machinery Council was also set up for advising the

Government on target for production, ensuring production and supply, effecting norms for efficiency in production, standardisation, distribution and pricing, promoting research, extension and adoption of agricultural machinery and implements etc.

Research and Development

The Indian Council of Agricultural Research (ICAR) is the main co-ordinating, promotion and funding agency for agricultural research and extension education and it attaches due importance to farm machinery education and research in the country. There are 19 Departments/colleges offering under-graduate and/or post graduate programmes in agricultural engineering producing about 400 BSc. graduates and 70 post graduates annually, at the same time contributing through basic and applied research. Agricultural engineering covers a wide range of activities which includes farm machinery and power, soil and water engineering, post harvest technology, dairy and food engineering, rural industry development, integrated rural energy systems, rural sanitation, rural transport, rural housing and aquacultural engineering. Considering the need for research and extension in these fields, a Central Institute of Agricultural Engineering (CIAE) was set up at Bhopal (Central India) in the year 1976 under the aegis of ICAR. The Institute has a Crop Production Engineering Division which undertakes research, design, development, laboratory and field evaluation of machinery and prototype manufacture of various farm tools, implements and machinery required for small, medium and large farms under dry and irrigated farming conditions.

The Farm Implements and Machinery Scheme has 16 co-operating centres located in various State Agricultural Universities and ICAR Institutes with co-ordinating cell at CIAE. The scheme has the objective of conducting research on the development of farm implements and machinery, manufacturing of prototypes, feasibility testing of improved implements, identification of implement packages for various food, oilseeds and pulse crops, development of training methodology and upgrading of skills of village artisans. The Agro Industrial Extension Division of the Institute works as a vital link between research and manufacturers in getting the proven prototypes commercialised. The division helps the manufacturers in improving the quality of the agricultural machinery already being manufactured by advising them on improved fabrication techniques and utilization of better materials. The Institute is also organising short term (1-3 months) and long term (more than 3 months) training programmes for national and international participants financed by RNAM, FAO, British Council and World Bank. The Institute has developed a number of useful technologies and equipment on all aspects of agricultural engineering.

The Central Mechanical Engineering Research Institute (CMERI) under the aegis of Council of Scientific and Industrial Research (CSIR) is another important institution engaged in applied research in the area of farm machinery. In a span of about 20 years, it has handled about 33 projects which includes development of a popular brand (Swaraj) indigenous tractor and 2 models of tractor-driven combine harvesters. In addition the tractor manufacturers in the country have set up modern R & D facilities. In the initial stages these departments concentrated on increasing the local content in the tractors manufactured. However, with the passage of time and increasing competetiveness, there was need to undertake real R & D work in tractor industry to change/amend designs to suit Indian operating and maintenance conditions. A number of current tractor models owe their development to local R & D efforts, including some diesel engines and hydraulic systems. The Gujarat State Agro Industries Corporation has set up a very good Agro Equipment Centre to undertake applied research (industrial designing) for commercialisation of institutional research (basic research). It involves selection of materials and processes, preparation of working drawings, manufacture of the commercial model and preparation of manuals etc.

Standardisation

The Indian Standards Institution (ISI) established in 1947 has contributed significantly in the development of the farm machinery industry in the country. At the insistence of the Union Ministry of Agriculture, a Farm Implements and Machinery Committee was set up in ISI in 1959. Initially, only hand tools and animal drawn implements were standardized. The work was progressively intensified and at present the following sectional committees have been set up and are dealing with various aspects of farm equipment relating to crop production and processing:

(i) Agricultural tractors and power tillers committee;
(ii) Soil working equipment committee;
(iii) Sowing, fertilisers and manure application equipment committee;
(iv) Crop protection equipment committee;
(v) Irrigation equipment committee;
(vi) Harvesting and threshing equipment committee;
(vii) Farm transport equipment committee;
(viii) Agricultural produce processing equipment committee;
(ix) Horticultural equipment committee;
(x) Agricultural Produce Milling Machinery committee;
(xi) Seed processing and technology committee;
(xii) Plantation and forestry machinery committee.

The ISI formulated over 300 standards on agricultural machinery covering

raw materials, components, entire equipment, test methods, glossary of terms, safety etc. These standards have been formulated to provide:

(i) Recognised level of quality
(ii) Framework for mass production and interchangeability
(iii) Incorporation of the latest results of research and development.
(iv) Simplification of production process and enhancement of labour productivity.
(v) Ensuring consumer protection
(vi) Lowering the cost of production

The ISI has also been empowered by the Government to operate ISI Certificate Mark Scheme on a voluntary and self-supporting basis. Under this scheme, the ISI grants licences to manufacturers for the use of ISI mark on their products which means that the Institution is certifying the quality of that product to the relevant Indian standards. Under this scheme, before a licence is granted, ISI carries out a detailed inspection of the manufacturing and quality control facilities owned by the manufacturer and after satisfying itself, the licence is granted. Validity of the licence is for one year and during the course of the year, the ISI arranges a minimum of six surprise inspections to the manufacturer's premises and thorough inspection is carried out during these visits.

During inspections, samples from the available certified stock of material as well as current production are drawn and sent to ISI laboratories. In addition samples are drawn regularly from open market or from recognised consumers for independent testing at ISI laboratories. Complaints are investigated and action is taken immediately. Apart from any immediate correction action taken on the basis of inspection and available test reports, at the end of the expiry period of the licence, ISI reviews the performance of the manufacturer on the basis of the inspection reports, test reports for factory as well as market samples, and decision to renew the licence is taken and this exercise is carried out every year. A wide variety of agricultural implements and machinery are covered under ISI Certification Mark Scheme. For the farmers who are not conversant with the suitability and quality of the equipment available in the market, certification mark is the answer. The institutions who provide finance to such farmers generally insist on providing finance to purchase certified equipment only.

Tractor testing

In 1943, when the question of importation of tractors came up for consideration by the Government and it was found that very little data was available in the country on which the drawing up of specifications for tractors and agricultural machinery most suitable to Indian conditions could be based. Indeed up to that

time the available records were nothing but stories of repeated failures of tractors which were imported with great expectation but soon found unsuitable. A committee set up by the Government in 1953 recommended that "..... the proposal for setting up tractor testing station should be finalised and the station should be set up as soon as possible. We feel that such an organisation is essential for exercising proper control over the various types and makes of tractors being brought into use". Accepting the recommendations, the Government decided to set up a tractor testing station at Budni and for this purpose obtained services of an expert from the Commonwealth Relations Office in U.K., who after a detailed study, defined the scope of work of the proposed testing station to include the following functions: To conduct tests on all makes of tractors, implements, engines, pumping sets imported or manufactured in the country; to find out their suitability under various soil and climatic conditions prevailing in the country; a special test procedure to be evolved; publication of test results; regulation of the importation of agricultural machinery on the basis of the conclusions arrived at by the above tests.

The Budni testing station has received assistance from Government of U.K. and under Japanese Grant Aid by way of supply of the special purpose equipment needed for testing of tractors. The test laboratory is now recognised by OECD for official testing of tractors. On the recommendations of the Agricultural Implements and Machinery Council, the Government in the year 1975 decided that all indigenous tractor manufacturing units should submit their tractors for testing at Government testing station at Budni once in two years so that they could upgrade the quality of their products by rectifying the defects observed during such tests. The sample for such tests are selected at random by an engineer of the testing station from the production line. Also there is a condition incorporated in the letters of intent/licence registrations at the time of its issuance that the tractor should be tested at Budni test station before commercial manufacturing is started. Thus, the policies of tractor testing in India are consumer oriented which works to the advantage of the farmers.

Training for Agricultural Mechanization

The setting up of the three farm machinery training institutes by the Government of India, first one at Budni (central India), second at Hisar (north India) and the third one at Anatpur (south India), have been a major step in training farmers and personnel of Government departments in proper selection, operation and utilisation of tractors and other power operated machinery. Agricultural machinery utilisation course (series 'A' course), which is of 3 months duration is meant for owners and operators of tractors, progressive farmers desirous of taking up mechanised farming, nominees of the state farms, seed farms, co-operatives, and

other organisations. The course content has theory (60 hours), demonstrations (100 hours), audio-visuals (20 hours), and field practice and other practicals (285 hours), making up a total of 465 hours. A significant part of the course is devoted to proper operations and maintenance of tractors and allied equipment. The focus of this course is utilisation of knowledge on farms. The refresher course on agricultural mechanisation (series 'B' course) is of 3 weeks duration and the content of the course is tailored to the need of the candidates who come on sponsorship. The subjects available are land shaping and land development machines, combine harvesters, irrigation machinery, power tillers, hydraulic systems and electric motors. The curriculum is spread over 160 hours containing theory, demonstrations, audio-visuals and practicals.

The technician course (series 'C' course) is of one and half months duration and meant for technicians of agro-industries corporations, co-operative institutions, state farms and also private mechanics. The course content is divided into theory (30 hours), demonstrations (45 hours), audio visuals (15 hours) and practice (135 hours), adding to a total of 225 hours. The under-graduate trainees course (series 'D' course) is meant for students of agricultural engineering during summer holidays. It is of one month duration. The content of the course is spread over 140 hours, with theory (6 hours), demonstrations (36 hours), audio-visual (8 hours) and practice (90 hours). The TRYSEM (Training of Rural Youth For Self Employment) course (series 'E' course) is of four months duration intended to help the rural youth gain useful skills and create avenues for self employment. After training they are helped in formulating a project proposal and obtaining financial assistance from banks at subsidised interest rate, for setting up repair workshop, cycle workshop, gas welding, flour mills, tyre and tube repair shops, implement rental shops, etc. The last course i.e. Trainers Training Course (series 'F' course) is of one month duration and meant to assist government departments and training institutions in creating their own training infrastructure to multiply the benefits of training in boosting farm mechanization.

All the above courses are open to foreign trainees also. The requests are processed by Ministry of Agriculture. These Institutes have adequate lodging and boarding facilities. Special training courses for foreign nationals are also organised by Central Institute of Agricultural Engineering, Bhopal and Indian Agricultural Research Institute, Pusa Road, New Delhi. These courses are designed on request to meet specific needs of the trainees. Most of the tractor and power tiller manufacturers organise their own training courses. Their on-the-spot training programmes for the tractor/power tiller owners, are quite frequent. They also use free-service visits as an opportunity for training farmers/operators.

Extension Services

There are three organisational systems devoted to agricultural extension namely (i) Union Ministry of Agriculture and State Departments of Agriculture (ii) ICAR extension system and (iii) voluntary bodies, business houses and other non-governmental organisations. A major effort in the past few years has been devoted to reorganisation of the agricultural extension set up in the major states of the country under the Training and Visit system (T&V) which seeks to bring about improvements in the extension services (Bernor 1984). As an integral part of the Training and Visit system of agricultural extension, a Monitoring and Evaluation (M&E) cell has also been created. From both the reports of the M&E units, and from independent evaluations it would appear that, by and large, the T&V system has got fairly well established in almost all the states.

The ICAR transfer of technology programmes are being implemented through ICAR institutes and agricultural universities. Some of the agricultural universities have created Farm Advisory Units (FAU) at district levels. There are four ICAR extension programmes in operation. These are (i) National Demonstration Project (NDP) (ii) Operational Research Project (ORP) (iii) Scheme of Farm Science Centres (KVK) and (iv) Lab-to-Land Programme (LLP). NDP was the first extension project launched by ICAR in 1964. It is intended to demonstrate the production potentiality of new technologies and to influence both the farmers and the extension agencies. ORP aims at disseminating the proven technology in a disciplined area among farmers on a watershed basis covering a whole village or a cluster of villages and concurrently studying constraints - technological, extension or administrative, as barriers to the rapid spread of know-how. This programme was launched in 1975. KVKs came into existence in 1974. There are 101 KVKs at various places in the country. They impart skill oriented and need based training in different agricultural operations to the farmers and farm women on the principles of teaching-by-doing and learning-by-doing. There is a proposal to establish one KVK in each district of the country in the next few years. The LLP was launched in 1979 adopting about 50000 small farmers and agricultural labourers to educate them on the latest agricultural and allied technologies and to encourage them to adopt these for their socio-economic development.

Credit

In India agricultural loans have been organised extremely well by the Government through a sound credit system which is responsive to the needs of the farmers and agricultural development in the country. The rural credit system is well streamlined through cooperative and commercial banks, regional rural banks and the National Bank for Agriculture and Rural Development (NABARD). It is estimated that about 95 per cent of tractors and power tillers, etc are purchased

by the farmers through bank loans. Regular directives are issued by NABARD to various financial institutions to finance equipment and machinery of established standard and quality. Banks normally insist on the borrowers buying machines which carry the ISI mark. NABARD has constituted an extension group for disseminating the principles of Development Through Credit among rural masses. These include:

(i) Credit must be used in accordance with suitable methods of science and technology.

(ii) The terms and conditions of the credit (techno-economic parameters) must be fully respected.

(iii) Work must be carried out with desired skill so as to realise optimum increase in income and productivity.

(iv) A part of additional income created by credit must be saved.

(v) Loan installments must be repaid on time and regularly to facilitate recycling of credit.

Currently NABARD is able to allocate for farm mechanization purposes about US$111 million (IR2 billion) per annum which participating banks seek as refinance. The credit requirement for agricultural machinery for the 8th plan period (1990-95) has been estimated to be US$6.23 billion (IR 112 billion). The gap is certainly large. This gap is supported by banks whose deposits are good. The difference between the two types of financing is in the rate of interest. NABARD refinancing cannot exceed 12.5% interest to the ultimate borrower whereas other banks may charge about 14.5% interest. NABARD has established a Research and Development Fund with a view to acquiring new insights into the problems of agricultural and rural development through in depth studies and applied research and trying out innovative approaches backed by technical and economic studies. For farm mechanization, some R&D proposals like development of paddy transplanters, fertiliser injectors, bio-gas plants, studies for minimum size of tractors for different holdings etc, have been sponsored under this fund. The important factor is that the project should benefit a large section of farmers and which may have future potential for growth.

Licensing Policies

At present an industrial licence is required for the manufacture of tractor and combines. In the case of other agricultural machines, no industrial licence is required. These units are only required to be registered with the Secretariat of

Industrial Approval or the respective State Industries Departments. The manufacturing of all manually operated tools, animal drawn or power driven implements is reserved to the small scale sector. Government's policy towards permitting foreign equity participation is selective and based on national priorities. The technical collaboration is considered on the basis of annual royalty payments, which are linked with the value of actual production. As regards to the importation of technology and upgrading of production system, the approach of the government is flexible. Importation of capital; goods for modernisation and upgrading of the industry by the existing manufacturers is considered on merit. In the case of tractor industry, there is flexibility on the range of models and size horsepower which can be manufactured. Manufacturers are also permitted to manufacture self propelled combine harvesters under the Broad Banding Scheme subject to certain approvals. Currently the importation of tractors and other farm machinery is severely restricted. The country is self sufficient and actually exports these goods.

Fiscal Incentives

The Government has exempted the following agricultural machinery from excise duty: Tractors with engine capacity of up to 1800cc.; power tillers, electrically powered centrifugal pumps used for irrigation purposes; all implements used in agriculture and horticulture; spare parts of all implements used in agriculture and horticulture, balers, mowers; harvesting and threshing machinery; processing machinery used for cleaning and grading of seeds and food grains; electrical motors used for manufacturing of submersible pump sets and monoblock pump sets.

EFFECTS OF POLICIES & STRATEGIES ON AGRICULTURAL MACHINERY UTILIZATION

In 1947, animals were almost the exclusive source of draught power and the multi-purpose wooden plough was the most common implement. Only a few farmers had taken up the improved tools like mould board plough, hand operated rotary chaff cutter, sugar cane crushers, etc. Irrigation pump sets were not common and tractors were almost unknown (e.g. there were then less than 8000 tractors in the whole of India). All crops were harvested manually with the sickle and the wheat crop was threshed by animals. The produce was manually winnowed and post harvest losses were considerable. Agriculture was an arduous task and rural youth were not interested to work in the fields. The situation has over the past 40 years significantly improved due mostly to proper planning and concerted efforts by all concerned (see Table 51). The following is a brief summary of the achievements in agricultural mechanization.

Tractors

Tractor production in the country started in September 1960. By the year 1961-62, only 880 tractors were produced, and this was done by assembly of imported tractor components. Owing to inclination towards mechanization by many farmers, Indian manufacturers were permitted to import a few reputable models of tractors from various countries and the tractor testing station at Budni tested these tractors to identify models which could be recommended for progressive manufacturing in the country. This approach proved useful in two ways - the Indian manufacturers with ready access to the foreign know-how were able to start commercial production with minimum gestation period and the farmers were able to get tractors of proven design. The foreign collaboration arrangements were approved by the government keeping Budni test reports in view. In mid 1960, the Central Mechanical Engineering Research Institute was working hard to develop indigenous technical know how for producing a low horse power tractor. They were successful and a public sector company, Punjab Tractors Limited took up its manufacture.

Currently, there are 19 companies licensed to manufacture tractors. Their total licensed capacity is 203050 tractors per annum. Out of these 15 companies have set up manufacturing facilities which have a total installed capacity of 112050 tractors per annum. They produce tractors of 12 to 75 horse power range. It is estimated that there were about nine hundred and fifty thousand working tractors in the country at the end of 1989. With the increase in tractor population, the gross cropped area per tractor has been reduced from 14800 ha in 1951 to about 200 ha in 1990. The average annual growth in tractor production during the period 1961 to 1966 was 48.2%. In terms of growth rate in production, India's record is unmatched. India has emerged as one of the leading tractor manufacturing countries in the World. Starting with a meagre annual production of 880 tractor in 1961-62, the production output has passed the 112,000 tractors number during 1989-90. A list of major tractor manufacturers in the country is given in Table 52.

In India, 30 to 39 hp tractors are the models most preferred models by farmers followed by 40 to 49 hp and 15 to 19 hp tractors. On the average the price is esimated at about US$140.00 per hp (Rs 2500.00). The general-purpose tractors are the most preferred ones because of their inherent advantages of being suited both for dry and wet land cultivation. However, tractors specially suitable for wet land cultivation, orchards, high clearance and wide tread units, etc will soon enter the market because of the increasing purchasing power of farmers in these specialised agricultural production segments. Farmers also prefer tractors fitted with a self starter, draught and depth control systems, cushioned seats and higher number of forward speeds. One area that may soon see major changes will be in

the availability of a wide range of tyres to make the tractor operation more specifically suitable for different kinds of soil and operating surface conditions. Engine models may also see improvements in terms of fuel efficiency, smoke, noise and vibration levels and weight to power ratio. Provision of front PTO and side PTO may also become available soon because of popularity of front mounted vertical-conveyor-reapers to the farmers. The tractor industry, having established a good home market, is now poised for a major export drive. Some established models have already been exported to Ethiopia, Kenya, Mauritius, Sudan, Tanzania, Zambia, Zimbabwe and Swaziland though in small numbers.

Power Tillers

India being one of the major rice growing countries and also having a very large numbers of small and medium size farms, led to the power tiller being considered to be the most ideal machine. As a consequence of this, private manufacturers were encouraged to collaborate and manufacture power tillers in the country. The first licence was granted in 1964-65. The present licenced capacity is 31000 tillers per year in 5 units. However, only 2 of them are in production and contribute over 90 per cent of the total sales which was about 16000 units during the year 1989-90. A list of power tiller manufacturers who have been granted licence is shown in Table 53. The reasons for low sales include: limited use of power tiller for custom hiring, cost of power tiller being high and need to walk behind the machine while working in the field.

Combine Harvesters

Self propelled combines for harvesting cereal crops are manufactured in the country under license whereas tractor drawn combines and reapers are reserved for manufacturers in small scale sector. The licensed capacity of the self-propelled combines is 546 units per year. The Government does not encourage import of combines or expansion of already created capacity as popularisation of combines may jeopardise the employment opportunities of casual labour force, more particularly migratory labour in the harvesting and processing sector of the agricultural industry.

Plant Protection Equipment

Until 1946, all plant protection equipment were imported. Local manufacturing started in the year 1946-47 and the Government banned the importation of these equipment. Presently, about 50 companies are manufacturing a complete range of plant protection equipment some of which are exported to different parts of the world, ranging from small nursery sprayers to power operated ones. The present

population of sprayers in the country is estimated to be 2.5 million units. The annual production is about 250000 units valued at US $25 million. With increased emphasis on agricultural production, this industry has assumed great importance. The production of agricultural sprayers has shown a rising trend during the last few years and it is estimated that annual requirements will increase to approximately two to three million in a few years time. The Government provides a 50% subsidy on this type of equipment to enable small farmers to purchase sprayers of certified quality.

Table 51 - Selected Agricultural Mechanization Inputs in Use in India 1945-1985

	1945	1956	1966	1977	1985
Draught Animals x 10^3	59333	70690	78517	8260	180500
Tractors x 10^3	5	21	54	270	608
Bullock Plows					
- Wooden x 10^3	27306	36142	39880	40766	-
- Iron x 10^3	487	1376	3521	6258	-
Irrigation pumps (Diesel & Electric)	21	160	886	4482	-

Implements

It is estimated that there are about 17000 manufacturers of agricultural implements in the country with an estimated turn over of US $195 million per annum. The implements manufactured include hand tools and equipment: ranging from spades/shovels, garden tools, all types of hoes, paddy weeders, seed dressing drums, rice transplanters, seed drills, sprayers, dusters, sickle, rotary paddy threshers, tubular maize shellers, ground nut decorticators, winnowing fans, chaff cutters, seed cleaners etc. Animal drawn implements include: blade harrows, mould board ploughs, disc harrows, cultivators, ridgers, bund formers, puddlers, land levellers, seed-cum-fertiliser drills, animal drawn carts, water lifting devices, reapers, etc. Power operated equipment: ranging from all types of ploughs and cultivators, fertilizer spreaders and distributors; seed cum fertiliser drills, all types of planters for grains, and sugar cane, all types of sprayers; all types of pumps, all types of irrigation equipment, combine harvesters, post harvest processing equipment, as well as seed cleaning, grading and packaging equipment.

TABLE 52: **List of Major Tractor Manufacturers**

S. No.	Name	Name of Collaborator	Model		HP Capacity	Licenced
1.	Escorts Faridabad	Motor Import Warsaw, Poland	E-330	35	25000	
			E-335	35		
			E-345	35		
			E-355	47		
2.	Escorts Tractors Ltd. Faridaba (Haryana)	Ford Motor Co.	Ford 3600	47	25000	
3.	Eicher Goodearth Ltd. Faridabad (Haryana)	BEBR Eicher Tracktoren, Fabrik	Eicher-241	24	30500	
			Eicher-242	24		
			Eicher-352	35		
4.	Mahindra & Mahindra Ltd. Bombay, Maharashtra	I.H. UK	B-275	35	25000	
			IH-444	45		
			IH-500	50		
5.	HMT Ltd., Pinjore (Haryana)	Motoknow Praha Czechoslovakia	HMT-2511	25	18208	
			HMT-3511	35		
			HMT-5911	58		
6.	Punjab Tractors Ltd. Ropar (Punjab)	Indigenous	Swaraj-735	39	12000	
			Sartaj	19		
			Swaraj-855	55		
7.	Tractors & Farm Equip. Ltd. Madras (Tamil Madu)	Massey Ferguson UK	MF-1035		35	12000
			MF-1040		39	
			MF-245	47		
8.	Gujrat Tractors Corp Ltd. Vadodara	Motokov Praha Czechoslovakia	Hind-G-453	46	7000	
			Hind-50	50		
			Hind-G-614	61		
9.	Harsha Tractors Ltd. Ghaziabad U.P.	Promoshexposts USSR	Harasha	31	10000	
10.	Kirloskar Tractors Ltd. Nasik Road Maharashtra	K.H.D. West Germany	D-3006k	35		
			D-4006k	43	10000	
			D-6006k	75		
			D-1006k	100		
11.	United Auto Tractors Ltd. Hyderabad (A.P.)	Industrial & Exports, Romania	U-445	45	5000	
			U-650		65	
12.	Pittie Tractors Ltd. Pune, Maharashtra	-	Pittie-2500	22	10000	
		-	Pittie-4500	39		
13.	Bihar State Agro Ind. Corpn. Patna (Bihar)	-	Zetor-2511	25	10000	
14.	Auto Tractors Ltd. Pratapgrah, U.P.	Leyland, U.K.	Pratap-284	28	12000	

***All manufacturers have installed capacity of about 50-60% of their licensed capacity**

The manufacturing of the above implements/equipment is carried out using semi-automatic, automatic and special purpose machine tools depending upon the volume of production, the degree of precision required and the magnitude of

investment. The manufacturing process varies from product to product but the most common operations involved in the manufacture of the implements are blacksmiths, press work, machining, assembly, painting and packing. On the basis of investment the industry can be classified as medium (US $1.7 million), small (US $0.17 million) and tiny (US $10000). The number of workers employed ranges from 4 to 50 workers and capacity utilization varies from 50 to 80 per cent. Some of the medium scale industries are exporting their products to other states and neighbouring countries. The numbers of a selected agricultural machinery and implements in India over the period 1945 to 1990 is shown in Table 51.

EMERGING LESSONS FROM THE INDIAN EXPERIENCE

India has made remarkable progress over the past $4^1/_2$ decades in agricultural mechanization. This progress is in all areas, manufacturing of agricultural machinery, implements and equipment, as well as in increased utilization of these devices on the farm. This has been at all levels of mechanization - handtools, animal powered implements to mechanically powered machinery and implements e.g. the number of draft animals in use has increased by about 50% between 1945 to 1985, while the number of tractors has increased by 2160% over the same period. Even more remarkable growth rates are shown for all the other agricultural implements and machinery.

TABLE 53: LICENSED/INSTALLED CAPACITY OF POWER TILLERS

S.No.	Unit	Collaborator/Make	Licensed Capacity	Installed Capacity
1	V.S.T. Tillers Tractors Ltd., Bangalore	M/S Misubishi Japan	5000	5000
2	Kerala Agro Machines Corpn Athani	M/S. Kubota	12000	3000
3	J.K. Satoh Agro. Machinery Ltd. Kanpur	M/s. Jay Kay & M/s. Sathoh, Japan	6000	6000
4	Krishi Engines Ltd. Hyderabad	M/s. Krishi (Akitu) Japan	5000	1000
5	Bihar State Agro Inds. Dev. Corpn. Patna	Kubota	5000	16000
		TOTAL	31000	31000

In India, mechanization of agriculture can be divided into the following four stages:

- First stage at which simple but improved manual and animal drawn tools are used,
- Second stage at which manually operated, animal drawn and simple, low cost power operated implements and equipment are used,
- Third stage at which relatively more advanced and power machinery are used, and
- Fourth stage at which complicated and specialized machinery and equipment are used.

Mechanization has often erroneously been associated with large scale tractorization in farm operations or introduction of big machines like combine harvesters etc. Mechanization, in its true meaning, is the application of engineering and technology developments to do a better job, more precisely and to improve productivity - be it with handtools, animal drawn equipment, power tillers, tractors, processing equipment, etc. In most of the developing countries, like in India, a selective mechanization approach, would seem to be the best. The following would seem to be the major lessons emerging from India's experience in agricultural mechanization.

Need for Agricultural Mechanization Studies

The Indian experience shows the importance of undertaking adequate agricultural mechanization needs study. A series of such studies were undertaken in India on a continuous basis by different working groups right from the 1940's. These working groups which drew representation from all sections - manufacturers, farmers' associations, state governments, research and development establishments, training institutions including Universities, were charged with the responsibility of formulating five year plan proposals on Agricultural Machinery and Implements and their proposals were after due consideration by the Planning Commission of the Government of India incorporated in the various national five year plans right from 1950's. The planning for agricultural mechanization had both short term (usually achievable within 5 years), medium term (usually achievable within 10-15 years) and long term (requiring more than 15 years to achieve) objectives. The planning also encompassed all forms of mechanization from handtools to mechanically powered implements.

One observation which can be made for most, if not all, developing countries, is that not adequate attention has been paid to mechanization policy in general and choices and appropriate levels of mechanization. The development of mechanization is in most cases focussed on only one option i.e. tractor importation, instead of examining a range of alternative packages of technology. A national level mechanization study is

the first essential step, in order to formulate a comprehensive plan for the systematic development of agricultural machinery and allied engineering industries. A micro level survey to form a long term mechanization strategy and policy for modernization of agriculture needs to be given top priority by developing countries. This study should come out with precise needs of the farmers and estimates of demands on a long term basis keeping in view the national agriculture policy. Another example is the growth of agricultural mechanization in South Korea, which has been very rapid during the last two decades due to favourable Government policies, among other things. In order to promote agricultural mechanization in that country, the Government enacted the Agricultural Mechanization Promotion Law on December 5, 1978, which gave both short and long term objectives. Similar planning is also essential in the other developing countries if they are to make rapid progress in the area of agricultural mechanization.

Establishment of Farmers Agro Service Centers

The second lesson from the Indian experience is the need to establish Farmers Agro Services Centres (FASC). Such centres should be established to supply farmers with the essential inputs for their agriculture. Small farmers have low investment capacity and lack access to new technologies. Unexploited agricultural production potentials, difficulties in meeting the requirements of essential inputs and services, unremunerative prices for marketable surpluses due to poorly developed facilities for storage and processing of primary products, lack of proper tools and equipment for improving the efficiency of operations and reducing drudgery, are some of the major areas requiring attention. It is in this context that the setting up of very larger numbers of Farmers' Agro Service Centres (FASCs) is crucial. Such centres should be set up to provide all services to farmers - including agricultural mechanization inputs. The centres as set up in India provide among other services - the following: selling of implements and other low cost equipment required for all field operations; distribution of seeds and fertilizers, feeds for livestock, animal health requisites, packaging and storage materials, as well as pesticides. The centres also provide technical services such as rental of animal drawn implements, provision of hiring services - for costlier machinery such as power tillers/tractors, threshers, sprayers, mobile pump sets, etc. In the more developed areas such centres provide more professional services like construction of irrigation canals, and simple irrigation structures, electrification of farm and rural structures, agro processing activities, drilling for water and installation of pumping equipment, raising of seedlings for horticulture and afforestation and even fabrication and manufacture of simple tools and implements (e.g. biogas plants etc.). The FASCs should be set up by - private entrepreneurs, village artisans, unemployed technical personnel, cooperative and marketing societies, or registered voluntary organizations engaged in agricultural and rural development. These FASCs should in so far as it is seemingly possible operate on purely commercial basis and should charge for their services on a competitive basis. Government departments, operating under the civil service regulations should not be involved directly in such ventures, but should assist individuals or groups of individuals to provide such services. Local government may assist by buildings the required infrastructure and then renting it out to the individuals concerned to provide such services.

For handling promotional functions such as training of entrepreneurs, manpower development, information dissemination, consultancy services, organization and management of technology transfer, setting up of pilot units, etc. a National Agro Service Agency may be useful. Such an agency will facilitate setting up of a very large number of FASCs and in sustaining and developing their activities with a relatively low government assistance. This proposed agency should form the apex national body for promoting agro services and agro industries. It would also help to provide base data for drawing up specifications of agricultural machinery most suited to local conditions. For setting up the agency, financial assistance initially can be sought from international funding agencies. On a long term basis, this agency should operate on self supporting basis. Every FASC should be required to be registered with this agency as a member. The membership fee should be related to investment/turnover of the FASC. The agency could also take a very small margin on supplies routed to FASCs through it. The agency should get its expenditure on training of entrepreneurs reimbursed from the Government. The sale of project profiles to the entrepreneurs could be another source of its revenue. To ensure that the assets created through use of grant-in-aid or loans from the government/financial institutions are utilized for the purpose for which these were given, guarantees equal to the grant-in-aid/loan amounts should be obtained. Failure to utilize the grant-in-aid/loan for at least a period of 3 years for the purpose it was given, should attract recovery within suitable financial penalty. There will also be a need to set up a monitoring and evaluation mechanism at district, regional and national levels.

Training of Manpower

Training of manpower is crucial for any successful development of agricultural mechanization. India realized this quite early and invested in training of its manpower in this area. In this regard the first Agricultural Engineering Educational Programme at BSc. level in India was started in 1942 at the Allahabad Agricultural Institute, Allahabad, Uttar Pradesh. The Indian Institute of Technology, Kharagpur, West Bengal, was the second institute to start a bachelor's programme in agricultural engineering in 1952. There has been a significant development of training, research and extension facilities in India from 1960, when the first Agricultural University was set-up at Pantnagar (Uttar Pradesh). By 1986, there were 27 State Agricultural Universities (SAU) in the country. As many as 10 institutions are now offering the undergraduate and postgraduate programmes in the field of agricultural engineering, many of them specializing in agricultural machinery engineering (Farm Power and Machinery). The total output of graduates in this specialization from all over India is estimated at over 350 BSc. graduates, with over 60 graduating each year with MSc. in Farm Power and Machinery (Singh 1988, Singh et.al. 1984, Ojha 1983). In addition, to the professional manpower there are over 400 institutions offering technician training at diploma level in agricultural engineering and mechanical engineering which produce each year 400 and 10 000 technician graduates in the two fields respectively all of whom find employment or are self employed in the agricultural machinery and implements manufacturing and servicing industries. Below these technicians are vocational training centres which produce 20 000 artisans each year (mechanics, welders, etc.) all who work

in the agricultural industry. There are also quite a number of institutions offering short term and on the job craft courses. Thus the Government of India and state governments set up numerous training facilities for all the three levels - artisans, technicians and professionals and this manpower has played a crucial role in the development of agricultural mechanization in India. It is important if the other developing countries wish to develop agricultural mechanization for them to set up the necessary training systems for all the levels of manpower required.

Research and Development Efforts

Research and development efforts in the field of agricultural machinery engineering, and agricultural mechanization is being carried out by many organizations in India. It is to the credit of these institutions that there has been significant progress in design and adaptation of machinery and implements to the Indian situation such that India today is one of the leading manufacturers of agricultural machinery and implements in the World. The production of tractors for example in 1990 in India is more that $2^1/_2$ times the total production of Great Britain which is a leading producer in the European Community market. Research and development efforts are spearheaded by:

(i) Agricultural Engineering Colleges and Departments in State Agricultural Universities system
(ii) Commodity Institutes of Indian Council of Agricultural Research (ICAR), numbering more than two dozens, Council of Scientific and Industrial Research (CSIR), (The Central Mechanical Engineering Research Institute (CMERI))
(iii) Private Organizations including tractor, engine, pump and other farm machinery and implement manufacturers
(iv) State Governments: Directorates of Agricultural Engineering and Engineering Sections of the State Directorates of Agriculture
(v) State Corporations: Agro-Industries Corporation, Khadi and Village Industry Corporation, State Farm Corporation, National Seed Corporation, etc.
(vi) Voluntary organizations and Individual Entrepreneurs.

All these research establishments work in close collaboration with the manufacturers and the farmers associations as well as the extension services.

Manufacturing Capacity

As already mentioned India has over the past 4 decades built up an impressive capacity in manufacturing agricultural machinery, implements and equipment. The current licensed capacity for manufacturing tractors is over 200,000 tractors per annum of different horsepowers with an installed capacity of about 115,000 tractors. Almost 95% of these tractors are sold within the country with only a small percentage being exported. The manufacturers of agricultural machinery and implements are both state

owned companies, private companies and individual entrepreneurs. All of them have received Government assistance in various forms in setting up their manufacturing enterprises. This includes research and development of prototypes, credit facilities, marketing assistance, quality control and testing facilities in state agricultural machinery testing centres as well as by the Indian Standards Institute, publicity, education of manufacturers and their workers, and assistance in procurement of raw materials. Some of the manufacturers have signed technology transfer agreements with foreign multinationals as shown in Table 52. The manufacturers have been integrated in the agricultural mechanization policy fora and they have been quite active.

Assistance to Farmers

The final part in promotion of agricultural mechanization in any country, is the assistance provided to the farmers themselves. This has ranged from education to the farmers on what is available on the mechanization side, how to use these new machinery and implements, assistance to small scale entrepreneurs and farmers in setting up their farm machinery repair facilities, capital subsidy for purchasing machinery and equipment, in the form of low interest loans, etc. There is also an extensive network of agricultural engineering extension workers who provide technical advice to the farmers. These are employed by the state governments, agricultural universities and the research system. All these provide invaluable service to farmers and have played a crucial role in the promotion of agricultural mechanization in India.

Agric. Mechanization & Employment

There has been an imaginary fear about employment problem as a consequence of adoption of tractor farming. India's experience has established that this is not true. Punjab, Haryana and Western U.P., which have higher tractor intensity than the other states face agricultural labour shortages throughout the year, more particularly during the harvesting, paddy transplanting, weeding and sugar cane harvesting seasons. During these seasons, the labour wages shoot up to 2 to 3 times more than the average wages. Studies also indicate that the family labour per crop-hectare declined by about 6%, permanent labour increased by 32% and casual labour increased by 18% with the shift from sole animal to tractor plus animal technology. Indian experience also indicates that small farmers owning tractors offer their machines for custom hiring for upto 700 hours in a year. This enables them to earn additional income of upto US$1,000.00 per year. Introduction of agricultural equipment also generates increased employment in production of equipment, their distribution, after-sale-service, repairs, operation, etc. A study done on the basis of a 14000 tractor manufacturing capacity plant in India indicated that every tractor so manufactured generated additional 0.8 man-years of employment of various categories.

CONCLUSION

India has made impressive strides over the past 4 decades in her agricultural mechanization efforts. The progress has been both in the power (energy) intensive

operations - e.g. primary and secondary tillage (i.e. there are virtually very few farmers who till their land using the hand hoe); transport, milling; pumping and other post harvest operations, as well as the control intensive operations e.g. seeding, weeding, pest control, etc. Equipment and implements which have significantly increased the productivity of labour and timeliness of operations in performing the various tasks have been developed, manufactured and adopted by farmers. The emphasis in this case has been to develop equipment and implements which can be powered by all three forms of power - e.g. human, draught animals and internal combustion engines. Further agricultural mechanization has been developed as part of the entire agricultural system and not in isolation. Careful planning has been used with short, medium and long term objectives. Coordination at national level has been quite effective and all the active players in this process have been involved in the formulation of agricultural mechanization policies and strategies. Even more impressive progress is going to be made in the coming decade. As has been mentioned elsewhere in in this volume, in the 1950's and early 60's the agriculture and food situation in India was similar to what pertains to Sub Saharan Africa today. The situation then was of extreme starvation, hunger and massive food imports. In the last two decades India has managed to transform her agriculture and today she can boast of strategic grain reserve of over 30 million tonnes, and other impressive agricultural statistics. There may be equity problems within the country, but at least the country does not need to import food. The drought of 1984 was even more severe than some of the droughts which occurred in the 1950's, but the country was able to ride over this using her own internal reserves. This transformation of the agricultural situation in India has been brought about by using improved plant materials (high seed varieties as well as drought tolerant varieties); fertilizers and plant protection chemicals; irrigation and agricultural mechanization. The utilization of above inputs has been facilitated by the creation of an efficient input supply and output recovery system. All the above are crucial to India's agricultural development.

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