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How Mechanisation of Agriculture helps in Maximisation of Production

By

SRI C. P. RAJU, B. A., B. SC. (Eng.), A. M. I. E.
Research Engineer

The Second World War, and particularly the Bengal Famine, have brought out poignantly how much Indian Agriculture and the Indian Farmer were neglected.

The emphasis in the previous regime was mostly on bullock and manual labour, which has landed the nation today in an acute food shortage. A few demonstrations with tractors and mouldboard ploughs were held, at a few research stations of this vast sub-continent and the visitors looked on it more as a tamasha.

In 1945, the total number of tractors in the whole of undivided India, including those that were brought in by the foreign armies were only about 13000, for an area of 220 million acres. The continued deterioration of the national food supply, the scarcity and high costs of farm labour, acute shortage of fodder and the high costs of maintenance of draft animals, have made the leaders and the agricultural engineers of the country think in terms of modernization of agriculture by mechanisation.

What is Mechanisation?: In simple language, it is nothing but man's mastery over nature in a systematic way and the use of its resources through mechanical devices. Mechanisation of agriculture is only a part of that process. It consists, in assisting animal and human labour in farming by mechanical power and ultimately in replacing both. Machine methods in farming, have made rapid advances in U. S. A., U. K., Canada, Australia and other Western countries. Today, mechanisation includes all operations on farms, like tractor ploughing, sowing and manure distribution with power drills and distributors, combine harvesting, water-lifting by electric or mechanical power, grading and processing of farm produce, transport by trucks and lorries, milking by electric milkers, spraying by helicopters and even kitchen operations by electrical and other accessories. The progress of nations, in the material sense, is judged by the amount of additional power available per worker in industry and agriculture. Prior to 1850, American agriculture was in the same condition as ours today. The machinery available per agriculture worker i. e. the additional horsepower per worker in dollars was only 17 in 1850. The value of the machinery per worker on the farm progressively increased to 30 dollars in 1870,

83 dollars in 1900, 190 dollars in 1920 and by 1948 the value of machinery per worker increased by 2½ times the value in 1920 and more than 25 times the value in 1850. The total value of farm machinery and equipment for production, privately owned, in 1948 stood at the colossal figure 8,338 million dollars (roughly 2,918·3 crores of rupees).

Table I below (furnished by Public Affairs Officer, United States Information Service, Madras) — gives sources of power used in ten farm jobs.

TABLE I

Operation.	Percent of work done with					
	Tractor machines		Animal drawn machines		Hand methods	
	1946	1939	1946	1939	1946	1939
Breaking land (plowing, listing, bedding) ...	82	55	18	45	...	...
Disking ...	85	57	15	43	...	...
Harrowing ...	77	43	23	57	...	...
Drilling small grains ...	79	49	21	51	...	...
Planting corn ...	41	13	56	81	3	6
Planting cotton ...	43	21	57	79	...	...
Planting potatoes ...	43	14	19	38	38	48
Cultivating corn ...	64	30	36	70	...	...
Cultivating cotton ...	45	21	55	79	...	...
Harvesting small grains ...	90	69	10	30	0·4	1

Even in 1939, the basic year for comparison, only planting of corn and potatoes and harvesting of small grains were done by hand methods. By 1946, the manual method in corn planting is reduced to 3%, potato from 48 to 38 per cent and small-grain harvesting from 1% to 0·4%. By 1946, the work done with animal-drawn machines is very much reduced and with tractor machines has increased. The percentages in 1946, of work done with tractor machines, in breaking land, disking, harrowing, drilling and harvesting are remarkable.

TABLE II

(Same source as table I)

Number of Tractors, Automobiles and Motor trucks in Farms.

(in thousands)

	Tractors	Automobiles	Motor trucks.
1920	246	2146	139
1930	920	4135	900
1940	1545	4145	1047
1945	2215	4184	1385
1948	3140	4934	1920

(Economic Almanac 1949)

The increase in the number of tractors is more than 12·8 times between 1920 and 1948. In the same period the number of automobiles is more than doubled and the trucks have increased more than ten times.

With the increase in power available per worker the output per worker on the farm has also increased. If the output per worker in 1939 is taken as the index number 100, 66·4 was the output in 1910, 86·5 in 1920, 89·8 in 1930, 103·5 in 1940 and 122·2 in 1946.

The gross farm income of the United States of America is raised with the increased availability of power.

Year	Gross income (in millions of dollars)
1910	7,352
1920	15,908
1930	11,388
1940	10,242
1945	24,665
1947	34,391

The increased use of machinery and power has made it also possible to extend the area under crops, as shown below.

Year	Total Farm Area (acres)	Farm area as percentage of total land area	Average Number of acres of farm land per tractor.
1	2	3	4
1850	293,561,000	15·6	...
1900	838,592,000	44·1	...
1920	955,884,000	50·2	3,881
1930	986,771,000	51·8	1,072
1945	1,141,615,000	59·9	515

United Kingdom: In 1946, 2,03,420 tractors served to cultivate 28,736,000 acres of crops and grass i. e. roughly one tractor for every 140 acres of land, including grassland. Tractors have further increased since then, to 3,00,000. Other machinery available for the farmer, are as follows (1946 census).

Name of machinery	No. available
Petrol and oil engines	178,490
Tractor Ploughs	178,950
Horse ploughs	303,240
Disc Harrows	65,200
Binders	149,500
Seed and Fertiliser drills	17 040
Pick Up Balers	1,900
Electric motors	54,260

Name of machinery	No. available
Corn drills	98,470
Tractor mowers	52,670
Horse mowers	175,640
Combine Harvesters	3,460
Milking machines	48,290

(L. F. Easterbrook, Agricultural Correspondent of the News Chronicle, London).

In 1946, the total annual value of farm produce is estimated to be £ 550,000,000 (Rs. 732·05 crores.)

U. S. S. R.: Until every recently, Russian agriculture was very backward in all respects. With its various plans in the last three decades, Russian agriculture has been modernized by mechanisation and other methods. The following table (from "The Socialized Agriculture of the U. S. S. R." by Naum Jasny — Stanford University Press) will show the progress achieved in mechanisation by the end of 1938.

FARM MACHINERY, 1928 and 1938

	Types of machinery	In 1928 (thousand units)	In 1938 (thousand units)
Tractors			
	Number	26·7	483·5
	Horse Power	278·1	9256·2
Plows			
	Primitive	4600·0	...
	Modern Tractor	9 3	493·5
	Horse	14000·0	5500·0
Drills			
	Tractor	0·5	265·5
	Horse	717·9	676·4
Grain Harvesters			
	Combines	0 0	153·8
	Binders, Tractor	0 1	10·7
	Binders, Horse	53 9	44·2
	Reapers and mowers	1299 7	896·2
	Threshers-complicated	5·6	130·8
	Threshers-relatively simple	552·0	297·4
	Beet Harvesters	0 0	19 3
	Trucks	0·7	195·8

The phenomenal increase in the use of farm machinery, especially mechanical power, in one decade is evident. The power of available tractors was increased more than thirty-fold, there were more than 1,50,000 combines and almost 2,00,000 trucks on Soviet Farms in 1938 as against virtually none a decade earlier. The change from inefficient indigenous methods to mechanised methods between 1928 and 1938 was little short of revolutionary.

MECHANISATION OF THE PRINCIPAL OPERATIONS IN AGRICULTURE 1928, 1932 and 1938

(percent of acreages)

Operation	1928	1932	1938
Plowing for spring crops			
Sokha	9·8	0	0
Plow			
Horse	89·2	81·0	28·5
Tractor	1·0	19·0	71·5
Seeding of spring grain			
Hand sown	74·5	51·7	12·8
Machine and horse	25·4	28·3	30·5
Machine and tractor	0·2	20·0	56 7
Harvesting grain			
Hand	44·4	35·4	8·5
Machine and horse	55·4	54·6	43·1
Machine and tractor	0·2	10·0	48·4
Combine and Tractor	0	4·0	48·4
Threshing grain			
Hand and other primitive methods ...	40·7	60·0	0·6
Threshers operated by horsepower ...	58·0		5·4
Threshers operated by mechanical power ...	1·3	40·0	95 0

Notable achievements in mechanised farm operations are, three-fourths of the total grain acreage was seeded by hand in 1928; by 1938 the proportion had been reduced to one-eighth; the acreage harvested by hand decreased from 45% to less than 10%; threshing by hand and animals disappeared.

An important item of activity in Soviet agricultural mechanisation is the establishment of Machine Tractor Stations, which are State organisations to perform farm operations with their machinery for the peasants' collectives. Previous to the Machine Tractor Stations, several attempts at mechanisation were undertaken by starting tractor columns machinery lending points, which were 56 in number owning about 1,496 small tractors in the spring of 1929.

The M. T. S.* was actually brought into being by an order of the Government in 1929, with a modest goal of serving one million hectares of cropped land by the end of the first year. The M. T. S. began functioning in February 1930. In 1930, there were only 158 M. T. S. in the whole of U. S. S. R. However, by greatly expanding the imports and by pushing up the domestic production of tractors, the organization of the M. T. S. was accelerated, as can be seen from the table below.

* Machine Tractor Stations.

Year	No. of M.T.S.	Tractors (thousand draw-bar Horse Power.)	Combines (thousand)	Trucks (thousand)	Tractor work (in terms of standard plowing) million hectares.	Combine harvesting (% of total grain acreage).
1	2	3	4	5	6	7
1930	158	87	0	0·1	...	0
1931	1228	681	0·1	1·0	...	0
1932	2446	1077	2·2	6·0	20·5	0
1933	2916	1758	10·4	12·3	35·2	0 7
1934	3533	2754	15 2	19·5	62·5	1 9
1935	4375	4282	29·3	27·8	100·5	6·9
1936	5000	5856	64·9	43·2	164 6	21·3
1937	5818	6769	104·9	60·3	202·8	33·7
1938	6358	7437	127·2	74·6	206·2	—
1939	6498	...	141·0	...	210·7	—
1940	6693	8292	148 0	40·3	211·3	43·0

From 158 Machine Tractor Stations in 1930, with tractors possessing a total of 87000 draw-bar horse power, the number has increased to 6693 stations in 1940 possessing tractors of total draw bar horse power 8,292,000. Similarly, the number of combines have increased from nothing to 148,000 and trucks from 100 to 40,000 during the period 1930-1940.

Europe: Under the caption "Agricultural Mechanisation and Europe's Economy", Mr. Montell Ogdon has given a survey of the progress of mechanisation under the European Recovery Programme. (Foreign Agriculture, March 1949). 21000 tractors were expected to be produced, in the year 1949-50 under the European Recovery Programme. The U. S. Farm Machinery Survey Mission has reported that there was a genuine need for farm machinery in those countries for efficient utilisation of land. These European Recovery Programme countries, have further committed themselves to reduction of draft animal production, increase of meat and milk animal production and at the same time to further expand the food crop acreage by mechanisation.

The Organisation for European Economic Cooperation has planned to achieve increased yields per acre of bread grain crops, by 1952. In Denmark, the increase in yields is expected to be by 20% over the prewar yields, in France by 28%, 31% in Greece, 9% in the U. K., 8% in Turkey and 7% in Italy: to be achieved by increased mechanisation and other modern methods of crop production.

Some of the important findings of the Organisation for the European Economic Co-operation Sub-Committee and the U. S. Farm Machinery Survey Mission are that the reasons behind the urge to mechanize are three-fold viz (1) realization of the importance of machinery in improving output; (2) desire by farmers to reduce costs; (3) necessity of solving the labour problem.

Farming machinery of the countries participating in the European Recovery Programme is proving to be an important factor in putting the agriculture of these countries on a more productive basis. In the European Recovery Programme countries there are quite a good number of small holding farmers along with many medium size and large holding farmers. Mechanization of these three classes of farms is taking place at a fairly good speed.

From the above data, the following conclusions emerge; (1) that mechanisation definitely helps crop production; (2) that mechanisation of farm operations and increased use of electric power for various processes in the farm house, the dairy, and the poultry are essential to increase the agricultural efficiency and output; (3) that by mechanisation and increased application of power, the drudgery attached to the slow and ineffective hand-methods is removed; (4) that by mechanisation, the employment of less suitable types of labour like women and children can be eliminated.

From the national standpoint, it is essential to look after the well-being of those engaged in this huge industry. The conditions of rural population and the agricultural workers, generally all over the world, and particularly in India, are far from enviable. Our agricultural workers have not attained even that quantum of standard of living enjoyed by those in other vocations in the cities. The solution for raising the standard of living of these workers, lies in mechanisation and making more cheap power available for them.

Our public opinion on mechanisation: With the above conclusions, let us examine the public opinion in our country. There are three schools of thought on the subject. One asserts that Agriculture is a way of life and that it should not be disturbed. Some of their important misapprehensions are mechanisation leads to reduction of draft animals and hence less farmyard manure for the fields.

However, well it may be cared for, there is a limit to the output of the bullock, the maximum limit being ½ h. p. Only a certain percentage of the total area, can be set apart for fodder purposes. Under these limitations, it is futile to continue to depend on the inefficient bullock for our farm operations, while the day-to-day maintenance costs for the same are mounting high. Even the small garden tractors, of 5 to 8 H P. are definitely more efficient than the best bullocks. So, by planned displacement of the bullock power, by machinery, not only is the crop production increased, but also the entire fodder crop of the land can be diverted to feed more and improve the breed of milk cows, which will yield greater quantities of milk and milk products. The increased number of milk cattle will also make good the possible loss of manure due to the

reduction of bullocks. There are also other commercial animals, like sheep and goats which if cared for more, will add to the wealth of the farmer and supply manure to his fields.

The second reason put forth is that mechanisation increases unemployment. The truth is, in our country, due to lack of opportunities by way of alternative sources of employment, there is over-crowding in the agricultural labour force; over-crowding by misfits, inefficient and superfluous workers. The result is high costs of agricultural production and low yields due to adoption of inefficient manual methods.

Contrary to the above apprehension, in the U. S. A. the strength of agricultural labour force has increased along with the wages, in proportion to mechanisation. While the total number of persons engaged in agriculture in 1850 was only 5 millions with increased mechanisation, the total has increased to 6 millions in 1870, 10 millions in 1900 and 11 millions in 1920. Of course, these workers would be more skilled and intelligent in handling agricultural machinery. In the year 1850, just preceding the agricultural machinary era, wages on the farms were from 8 to 12 dollars per month with board. The average farm wage rate for U. S. for subsequent years, has increased manyfold.

Year.	Monthly wages without board (in Dollars.)
1	2
1866	15·5
1874	17·1
1890	20·02
1902	22·12
1919	56·77

(1926 Year Book. of the U. S. Dept. of Agriculture)

The third reason put forth is on grounds of sentiment. In the world of hard realities, sentiment has no place.

There is a second school of thought, diametrically opposite to those of the first, which urges speedy mechanization and supply of maximum power to agriculture, at all costs. Some of the arguments put forth are that the goal of a nation, as of an individual is to obtain the maximum results with the least effort; the whole economic progress of mankind consists in getting more production with the same labour; it is for these reasons that the wheel and the wagon, rail-road and motor truck were invented and above all, agriculture must be viewed as an industry and all devices that increase the output per worker must be made available to this most important primary industry of the country.

The third school views, along with the second school, agriculture as an industry, feels that greater power per agricultural worker must be made available, in this industry along with others but thinks that mechanization, in India, has only limited application in such operations, as cannot be undertaken by bullocks and man, efficiently, viz., (1) power irrigation; (2) breaking up of new lands; (3) eradication of weeds; (4) agricultural in sparsely populated areas; (5) harvesting and threshing etc., where seasonal shortages of labour, may lead to losses due to untimely operations and (6) other large-scale constructions of contour bunds, embankments, drainage and irrigation channels etc.

It is true that the high-powered tractors are pre-eminently suited for those large-scale operations. But the modern trends in Agricultural Engineering are to supply multipurpose tractors and implements, to suit the different types and sizes of farms and to be useful under varying soil, crop and other conditions.

The impression that the tractor is of limited use in Indian Agriculture, might have gained ground because of the use of large-powered tractors by the Povincial Governments, acquired from the Army surpluses. To clear such wrong impressions, to determine the various uses in Indian Agriculture of tractors and implements, and to build up public enthusiasm on a scientific basis, experiments on an All-Mechanised Farm have been started recently in the Agricultural Engineering Section, Coimbatore. These preliminary trials have shown that the tractor can take up most of the operations in our agriculture. The experiments are being continued and will be conducted over a 3-year period with a view to further examine the following :

Problems : (1) Costs and other economic aspects; (2) relationship between the drawbar pull required for the particular implements and the mechanical structure of the various soils of the State of Madras and (3) effect on yields.

These experiments are designed also (1) to determine the limitations of the imported tractor implements under our climatic, soil, crop and other conditions. And to advise the agriculturists, on the selection of the right type of tractor with a set of imported implements suitable for a particular crop, soil and other conditions for 'Standardization of the Horse Power and the minimum set of implements required' for the various regions and crops of our Province and (2) to design or modify bullock implements to hitch them behind the tractor.

Some of the other important handicaps against the popular use of the tractor in our agriculture are lack of (1) necessary capital, (2) required number of machines; (3) machines suiting our

requirements; (4) cheap fuel (5) necessary skill and machine-mindedness; (6) workshops and servicing facilities and (7) alternative sources of employment to the workers displaced from agriculture.

These may now be examined to surmount, to devise means, taking Madras State itself. It is acknowledged by all, that the means of production in our agriculture are very inefficient and slow. Our agriculture is in the same condition as American agriculture was in 1850. Hence, we have to make up for this time-lag of a century by the adoption of planned mechanisation. With that end in view, holdings can be roughly grouped into three- All pattadars paying kist above Rs. 30/- and upto Rs. 1000/- are grouped as large-size holders; similarly those paying kist Rs. 30 - and below, but above Rs. 10 - are treated as as medium size landlords and all others paying less than Rs. 10 - as kist are small-size land holders. Thus there are about 4,14,721 large holdings with a total acreage of 8,799,599; 1,156,992 medium holdings covering a total acreage of 7,585,557 and 5,118,111 small holdings with a total acreage of 11,254,348 acres.

Madras is leading in the field of mechanization too. Our activities in this field, began from 1946, with the establishment of District Tractor Stations by the State. In this brief period of barely four years, along with the achievements under land reclamation, improvements to tanks, intensive cultivation and other activities, the Agricultural Engineering Section of the Department has roused the enthusiasm of the ryots to a high degree.

With all this, only the fringe of the problem is touched. To cut short the time lag and to place this state on a par with the progressive countries of the world, more State aid in the inital stages, is essential.

If the industry is viewed from another angle viz., the amount of Horse Power of machinery available per agricultural worker, the necessity for immediate State aid will be quite plain. In the year 1939–'40, for the total labour force of 4,774,000 on the farms of this state, there are oil engines, electrical pumpsets, sugarcane power crushers and tractors, of an aggregate horse power 73,685, which works out to roughly 0·015 horse power per worker. By 1947–'48 the total horse power of the above machinery has increased to only 85,582, thus making available per worker about 0·013 horse power of machinery. This increase in the horse power is mainly due to the increased activities of the Agricultural Department.

This is the largest industry of our State, with maximum capital investment and the one single industry employing maximum number of people.

Table showing the investment and gross income in Madras State during 1939—40 and 47—48.

Items.	1939—40		1947—48	
	Total Investment in Rs. Crores	Gross income in Rs. Crores	Total investment in Rs. Crores	Gross income in Rs. Crores.
Agrl. Land Cultivated area only (excluding Forest.) ...	1000	166	2127	498
On Live Stock ...	66	50	212	200
On Machinery, Ploughs and tools ...	21	...	56	...
Total ...	1087	216	2395	698

Agricultural Labourers — 4,774,000 (approx. from census '31)
Total engaged in Agriculture including land owners —12,570,000 (From "Rural Problem")

In a broader sense, it is the only industry devoted to the production of food and of raw materials used primarily for food, shelter and clothing.

In America in 1948, when the total value of farm land was 62,813 million dollars, the investment in farm machinery and equipment was 8,338 millions. which is about 13% of the value of the land, whereas in our State, in the year 1947-'48 the value of the agricultural machinry etc., was only Rs. 56 crores as against the land value of Rs. 2127 crores which is only 2·63% of the value of land.

Hence, it is our paramount duty to modernise the means of production in agricultural practice. As the problem is a huge one, it is to be accomplished only in stages. In the first stage, the four lakhs and odd large holdings mentioned above have to be equipped with suitable machinery and equipment. The tractor and implements have to be standardized, by exhaustive trials and studies, with reference to the crop, soil and other factors. And in the initial stages, the State have to supply them at fair prices.

Similarly standardization of the tractor and set of minimum implements has to be undertaken by the Government, to cater to the requirments of 1,156,992 medium size holdings, which will be mechanised in the second stage-

When once the types of tractors and implements are standardised, with reference to the size of the holding, crop, soil and other factors, the demand for the same, among 1,571,713

farmers (large and medium) is certain. This is the potential market. The panel on Automobiles and Tractors constituted by the Government of India, in 1945 under the Chairmanship of Mr. K. C. Mahindra, has reported, that 4000 units of one type of tractor is considered an economical volume for purposes of assembly and that Government should take on the responsibiility for initiating action in regard to tractor and agricultural implement manufacture. Here is the solution for mechanising all the farms. By the manufacture of tractors and implements in the province, large sums of money that have to be spent annually for imports will be retained, machinery at fairly low costs can be made available to suit the conditions of the different types of farmers; further stimulus to the industrial expansions would be given and the superfluous labour, that are now depending upon agriculture can be more advantageously diverted into fruitful channels.

Mechanisation of the 5,118,111 small holdings, of the State with a total acreage more than $1\frac{1}{2}$ times that of large holdings, has to be undertaken in the third period of development, with State aid. Agricultural Engineers and manufacturing firms of the West are now engaged in solving the mechanical problems of the small farmer, to supply him with low horse power tractors mounted implements and other accessories at a cost suiting his purse. Research on similar lines, to solve the problem of our small farmers has to be undertaken and designs suitable, have to be evolved, to initiate the third stage development.

By the beginning of the third stage of development, our agriculture and industries, can be expected to be more prosperous yielding large revenues to the State. Expansion of agricultural machinery industry, to cater to the small farmer has to be taken up and they too have to be brought in line with the others, by supplying on instalment purchase and other systems.

Alternatively, these small farmers, can be brought under Co-operative Agricultural Machinery Societies. Or their machinery requirements can be met by increased number of District Tractor Stations of the Government, and through the agency of private contractors under State Control.

For the successfull completion of these programmes, and to ensure low costs of operation of the power mechinery on the farms, cheap fuel supply is to be assured. The cost of petrol is prohibitively high and petrol engines and tractors, do not appear to have a future, until geological explorations reveal fresh and plentiful supplies of oil in our country. Though diesel engines are a little intricate, they alone hold out hope for the present, to our farms, since diesel oil is comparatively cheaper.

The Union Government, have to negotiate with the oil companies to restrict their margins to the bare minimum on all diesel fuels and power kerosene for farm purposes. The "Agricultural Machinery" Journal, June 1950, announced the details of Ferguson Lamp Oil Tractor, designed to run on Zero Octane fuel after it is started on petrol. Further researches on the use of lamp kerosene oil, and other cheap indigenous oils, as fuels for farm engines, have to be undertaken immediately in our National Engineering laboratories.

It is often pointed out that our rural population is lacking in the necessary skill and machine-mindedness. But it is from the ranks of the same rural folk, lakhs of skilled mechanics, drivers and workers for other mechanical trades were drawn for the World War II. They have not only picked up the new trade in the shortest period but have also won the war. In recent years a few farmers of the province have gone in for tractors and not a few of them are being manned by the farmers' sons. Given the proper facilities to learn, the Indian farmer will never lag behind his counterparts of the West. It must be insisted that every firm importing tractors and implements should provide ample workshop facilities spread over the whole of the State, and should train the farmer or his son in the manipulation and maintenance of the machinery purchased from the firm. The facilities by the commercial firms can be supplemented by taking in for training, batches of nine farmers, at the two Government Tractor Workshops.

To-day commercial Firms, are taking advantage of the public enthusiasm in favour of agricultural machinery, by trying to dump on the ryots, their machinery with very meagre or no retail stores for spares and servicing facilites, This is likely to end in enormous losses to the ryots, by improper selection of machinery and machines lying idle for want of spares and servicing facilities. If the above contingencies arise, they will lead to a positive set-back to the mechanisation programme of our agriculture. To avoid both, it should be stipulated, that every machine before it is sold to the farmer must be subjected to exhaustive tests in the Government Agricultural Engineering laboratories as to their suitability to our provincial aricultural practices. Similar tests are conducted at Nebraska in the U. S. A. and relevant test data are published for the information of the farmer. Imports and sale of agricultural machinery must be restricted to the approved models only.

The second condition to impose on the importing firms is, when once a particular machine is certified to be suitable for a region, the firm should open a chain of servicing stores. The efforts of Messrs. P. S. G. & Sons, Peelamedu in this line are worth mentioning. In addition to their factory at Peelamedu, there are their retail stores and servicing stations for their machines in a few

taluks of the Coimbatore District. "Farm Implement Retail Stores" is an essential adjunct in the mechanisation programme, as is evident from the following data on the retail stores in U. S. A.

Year.	No. of retail stores.
1929	12,242
1935	9,637
1939	10,499

(Statistical Abstract of U. S. A. 1949).

Elsewhere. it is pointed out, that progressive mechanisation of agriculture instead of creating unemployment, has increased the total labour force of the industry in U. S. A. Similar increases in employment are noticeable in the U. K. as well, from the table below:

(From "Agriculture in Britain" issued by Reference Division, Central Office of Information, London, W. 1.)

Employment in Agriculture in Great Britain (1936—1949)

	(in thousands)			Women's Land Army.
	Total	Males	Females	
1936, ...	751	657	94	...
1938, ...	697	610	87	...
1940, ...	712	602	110	8·8
1942, ...	824	627	197	59·0
1944, ...	863	647	216	78·0
1945, ...	887	683	204	65·3
1946, ...	889	732	157	33·8
1947, ..	892	746	146	26·9
1948, ...	850	703	147	25·4
1949, ...	852	717	136	16 3

* Great Britain. The figures include all those in full-time employment in Agricultural, Horticultural and timber work.

It is a natural consequence of planned mechanisation, to bring in more land under cultivation and develop some of the neglected agricultural pursuits, like dairying, horticulture, vegetable gardening, fruit gardening, poultry and so on, engaging thousands of skilled workers. The chain of retail stores and servicing stations for agricultural machinery, spread over the whole State, the factories for that would be started for the manufacture of various types of machinery from tractors, implements, sprayers to electrical incubatores, milking machines etc., and the mechanised small scale industries would absorb all the rural population, and give them full employment, instead of the under-employment of the present times. Hence, it is evident that to solve the food shortage in the country, extensive and intensive growing of various crops is an immediate necessity.

How crop production can be increased tn our State: It can be achieved by (1) extending the area under crops after reclamation with bulldozers, tractors and tractor-drawn implements; (2) increasing the irrigation facilities and (3) intensive cultivation in those areas that are already under the plough, with the aid of modern agricultural machinery.

A major portion of the agricultural engineering activities of our Department, through the district tractor stations, for the last four years, will come under the first category mentioned above. Our ryots have utilised the services of the departmental machines, to the maximum, for bringing greater areas of fallow lands under cultivation. Realigning the levels of fields under private ownership to suit the wells located in them, with the aid of bulldozers, in the Coimbatore District; the excavation of private tanks to store greater volumes of water for irrigation of paddy fields of Malabar, the spring channel excavation in the Chingleput district and removal of sand and silt from the fields affected by the recent cyclone in the northern districts are a few operations of outstanding importance, which were undertaken by the departmental tractors. These and the various other works undertaken by the departmental machinery are of such nature, that they could never be expected to be undertaken by manual labour and even if undertaken by hand implements, it should be at prohibitive cost, extending over long periods.

Till now, the extension of area under crops was left to private initiative, and the State has given out on hire machinery to such of the ryots as had asked for them. There might be a good number of ryots in the State owing large areas of weedy or fallow land or scrub jungle, who due to straitened financial conditions, could not go in for hiring the departmental machines. We cannot allow this awkward situation to continue. The reclamation of these areas has to be undertaken by the State and the hire charges may be collected in instalments from the ryots beginning from the end of first crop year. There are also large tracts of scrub jungle or fallow lands fit for crops, in some districts. These should be reclaimed, and weeds should be eradicated by tractor ploughing and then handed over to ryots, for raising food crops. Nominal charges for reclamation, may be collected, in these cases on an easy instalment system.

Increasing irrigation facilities — wells: Large river projects are being developed along with the renovation of irrigation tanks to make available enough water supply for the crops in areas which until now are dependent upon an uncertain and meagre rainfall.

Irrigation wells are the third biggest item, in our State under this head. Every district, including those under the three major irrigation systems, Godavary, Krishna, Cauvery have wells which are supplying water for crops. There are, according to

the "Season and Crop Report–1945–'46" about 85,877 irrigation wells in our State; of which about 519,635 are located in the six districts, of Chingleput, North Arcot, South Arcot, Salem, Tiruchirapalli and Coimbatore.

There is still ample scope for bringing more acreages of crops under well irrigation, by tapping underground water resources. Of the three major water supply sources, wells can be dug the cheapest and in the shortest time. Also. it may be a long time before the large river projects are developed and water is made available for irrigation to such of the areas that are even now dependent upon the vagaries of rainfall, with consequent uncertain and indifferent yields of crops. Hence, a systematic survey of the underground waters have to be undertaken with the aid of modern scientific instruments; sites for wells have to be located accurately and dug by modern machines which while ensuring low costs, will complete the work in the shortest time. For purposes of planned development and to avoid losses, this task has to be undertaken by the State.

Water from wells can be lifted efficiently by power, either mechanical or electrical. The efficacy of electric power for water pumping is well known. Out of the 8 lakhs and odd wells of our State, not to speak of the fresh wells that might be excavated in future, only a few thousands might have been fitted with electrical and oil engine pumpsets. Development of an electrical grid, to make the energy available to all the wells and the villages, is an immediate necessity. Assurance of timeliness of operations, like threshing, processing, grading etc. of crops, at low costs, is a great incentive to the farmer for maximum production, and cheap electrical energy is the only aid for this. Every progressive country, that has aimed at maximising its crops, has supplied electrical power to agriculture, on a preferential basis, at very low tariffs. By the adoption of such tariffs which will stimulate the agricultural load, the load factor, the diversity factor and the power factor of the supply systems have been found to be improved to the advantage of the system. So, there is considerable scope and necessity for the revision of the provincial electrical tariffs for agricultural purposes.

Replacement of bullock and manual labour, in lift irrigation, by mechanical and electrical power, while assuring continuity and efficiency, will make available larger quantities of water in time, to the crops. So this replacement should be completed, in a targeted period of years. It can be achieved only with State aid.

Maximisation of crop production by intensive cultivation: As already pointed out, modern agricultural machinery is utilised in the Western countries not only for reclamation of waste lands and extension of areas under crops but also for day-to-day operations in agriculture.

In recent years, the average size of holdings in the U. K. and the U.S.A., is coming down and the number of small holdings is on the increase. The trends in the present time agricultural engineering are, a tractor for every farm and an implement for every operation. The high costs of labour and maintenance of animals is the experience of both the small and large holding landlords of our State. The margin of net income appears, therefore, to be too low to offer sufficient incentive for increasing the yields.

In areas, like the Ceded districts, the rainfall is meagre and all of it will come down in a brief period either in time or late. Often, preparatory cultivation, sowing etc, have to be done swiftly after the first rains. Hence all the area is either not cultivated or cultivated imperfectly.

In the deltaic districts also it is the same story; land is either left fallow or weeds are imperfectly removed due to the high costs of the prevailing methods. Partial success in deep ploughing is possible only after a number of ploughings with bullocks. In some other areas, even with the availability of irrigation facilities the ryots could not be benefited, due the irregular levels of the fields. Our manure spreading methods are inefficient and our seed rate in broadcasting is higher, compared to those obtained with machines. In all those cases, the yields of our crops are low and at high costs.

Mechanisation comes in handy by way of perfectness of operation, larger turnover per day, low costs, timeliness and increased yields.

Appreciating the importance of machinery in agriculture, enquiries about a suitable tractor and set of implements, are being sent in, by the ryots, in increasing numbers, to the Agricultural Department.

To sustain their enthusiam and to convince them with data based on exhaustive trials, under actual farm conditiods, studies on All Mechanised Farm", have been started at Coimbatore. A thirty-acre plot of the Millet Breeding Station, representative of, the provincial medium-holding class of the rain-fed type is selected to collect data on costs, yields and other aspects as mentioned previously.

A "Calendar of Operations" is drawn up for the year, in co-ordination with the the Millet Specialist and the selection of machines and implements is made sufficiently in advance. The studies are in progress and will be continued over a three-year period, to obtain data on the effects of mechanization, on our agriculture. A few of the reults obtained till now are furnished below.

"ALL-MECHANISED FARM"

Studies on the draft requirements of the various tractor implements on different soils.

Sl. No.	Date	Type of soil	Field No. and Plot No.	Operation	Implement	Tractor	Depth	Width	Dia. of disc	Draft in lbs. With load	Draft in lbs. Without load	Draft in lbs. at head lands	Running costs acre	Remarks
1	12-2-1950	...	...	...	Two-furrow disc plough	Massey Harris 20k	...	...	...	890	...	...	9-9-6	Though not coming strictly under the experiments, are interesting and contributory.
2	11-2-1950 10 A. M.	...	F. 36-A	...	Massey-Harris 3 disc plow No. 504	W. 6	...	...	...	1287	...	300	5-7-9	
3	13-2-1950 11 A. M.	Black sandy loam	F. 37-A	...	3-Disc plow	W. 6. with pneumatic wheel	...	...	...	1st gear 1370	314	913	5-7-9	
4	28-4-1950	Red loamy dry land	F. 11 MBS	Covering F. Y. Manure	28-Disc Harrow (Ransome's)	T. D. 14 A. No. 2	3-5"	8-0"	1-8"	gear 1st 1730 2nd 1688	...	...	...	*The wheeled type tractors could not negotiate in the ploughed lands, for this operation. Hence it was replaced by a crawler type one. The turnover per day is 19 acres.
5	1-5-1940	Red dry land	F. 37 Plot No 1	do.	28-Disc Harrow (Ransome's)	T. D. 14 A No. 1	3-25 to 3-5"	8-0"	1-8"	2nd gear 1449	...	824*	...	
6	1-5-1950	Black cotton soil (dry land)	Field No. 27 Plot 2	do.	do.	do.	do.	8-0"	1-8"	2nd gear 1575	...	...	...	
7	10-2-1950	...	Filed No. 7 1 5 acres	Sunhemp plowing in Sugarcane Br. Station	Three Disc.	W. tractor with iron wheel at the rear	6½"	...	...	1st gear 1614 2nd gear 1189	884	735	...	Remarks on items 1, 2 & 3 hold good.

The implements used in all theses operations are modern tractor implements, which are designed for perfectness of operation and increased turnover per day. From the readings, obtained under draft, it is clear, that the bullock and man are far behind. So continuance with such low power aids will only lead to poor results.

Hariali is one of the worst weeds, which is common in black soils. It develops a mass of roots which run through the soil in all directions, creating a mat to choke the crop plants. The depth of the matted roots varies from 10 to 12". To eradicate this weed, the soil should be turned to expose the roots to the sun. The depth of ploughing should be at least 10". It is a very hard task for both man and animal. Recent experiments on weed eradication with tractor implements at Field No. 37, Central Farm, Coimbatore have brought out the following results. Cost of digging by crow bars per acre, worked out to Rs. 263/- whereas a D. 6 Tractor with 28" four-disc plough on another plot of the same field gave a turnover of 4.4 acres per an 8-hour day. The eradication was found to be 90% perfect, the average depth of ploughing being 9" and the running costs per acre worked out to Rs. 6/- only. Comparative studies on yields etc. will be continued.

While following the "Calendar of operations" the under-mentioned factors are also kept in view :—

1. That our crop practices like the inter-row spacing and intermediate applications of guntaka etc. are perfected for bullock and hand implements. Introduction of sudden drastic changes in these practices should be avoided;

2. Our ryots are willing to go in for a tractor, though it is costly but are rather reluctant to go in for the costly imported implements whose performances they are not sure of;

3. Some of our agricultural implements like the guntaka, bund former and the mechanical seed drill, which are unique, are so well known to the ryots, in their construction and performance, that the possibilities for modifications to hitch them behind the tractor have to be explored, to reduce the capital investment. and to create confidence. Also most of the village black smiths can handle their servicing and repairs.

For irrigated crops, bunds are being formed by the bund former, drawn by a pair of bullocks. These bunds divide the field into plots of 10' by 30' with a trench for water flow between every two longitudinal rows of plots. Inspite of the use of dead weight and pressure by the man at the handle, the formation of the bunds is not perfect and the acreage bunded per day, is also low. Thus it is resulting in inefficient utilization of the meagre water

supply. To overcome this difficulty and to increase the turnover per day, two bund formers with 10′ spacing between were bolted below an angle iron frame mounted on wheels. This has been tried by hitching behind the tractor. The formation of bunds was found to be more perfect. While the cross bunds were being formed, one of the formers would be removed and the other would be adjusted to go behind the rear wheel of the tractor thereby minimising the manual labour at cross cuts. By these preliminary trials, it was concluded that the bund formers could be hitched behind the tractor to increase the turnover and to minimise the idle hours of the tractor. A more efficient utilisation of the meagre water supply for irrigation could also be achieved.

After the first few summer ploughings, it is the practice of our ryots to run the guntaka twice or thrice after the rains, to cut the roots of the sprouting weeds, without disturbance to the top soil. This guntaka is drawn by a pair of bullocks or two in some cases. Though this is a very light operation requiring low draft, often the turnover per day is so low that the ryots are being forced to complete the job imperfectly or leave some land fallow. Utilizing the principles of construction of the guntaka, a similar implement six feet in length was designed and bolted to the same angle-iron frame as above and hitched behind the tractor. Preliminary trials with it in July 1950 have proved that the cutting of the roots of the sproutings is perfect and the turnover is increased many times. The draw bar pull required for the tractor guntaka in the black soil area of the Millet Breeding Station, Coimbatore is 1400 lb; similarly in red soil area the draft is 912 lb. Further trials on this design are being continued. When this simple implement is perfected, the tractor owner who can obtain it at a very low cost, can not only operate the guntaka on the whole area but can also put his tractor to greater use in agriculture.

The evolution of the standard angle-iron framework, which will take in, either the bund-former, the guntaka or any other implement of ours, is also being worked out at the Research Engineering Section. By possessing either one or two sets of such standard framework, more tractor working hours in our agriculture can be achieved, at minimum capital investment. The operations will be more perfect and in time, resulting in increased crop yields.

Utilization of the tractor power, to run the processing machines, like thresher and chaff cutter, to run the pumpset at the well for irrigation, and the tractor with a trailer as a means of transport are being resorted to by some of our ryots. With the increased popularity of modern machinery among our agriculturists, in the coming years; along with increased yields and increased profits, a more prosperous agricultural community will emerge.

With a view to achieve planned and successful mechanization of our agriculture, the following additional proposals are made. These have to be accomplished in stages, by the end of about fifteen years.

During the 1st stage: 1. Extension of research in Agricultural Engineering by the establishment of three more stations, one for the Ceded districts, one for the Northern zone and one for the Central zone of the State.

2. "Extension service" branch for engineering, manned by trained agricultural engineers.

3. Starting of large-scale District Demonstration Farms, equipped with power drive, suitable machines and implements with workshops and servicing facilities.

4. Initiation of Degree courses in Agricultural Engineering in one of the Universities of the State, to supply the officers to man the various schemes.

5. Training in Agricultural Engineering of a selected number of candidates annually, in a few of the Polytechnics of the State Engineering. At the end of the training, the successful candidates will be awarded the diploma in Agricultural Engineering, similar to the diploma in Automobile, Radio or other branches of engineering. These licenciates are to man the lower categories of posts.

6. Training the rural population in maintenance and running of agricultural machinery;

7. Arrangement of sale of tractors and implements etc., on easy instalment system to the ryots;

8. Encouragement to private capital to start in the different regions, factories for the manufacture of implements.

In the 2nd stage: In addition to the extensions to the activities of the 1st stage, the following new programmes should be initiated.

1. Establishment of a factory for manufacture of medium-size tractors and suitable implements;

2. Tractor and implement testing stations.

3. Development of research stations with a view to cater to the small holding landlords;

4. Establishment of co-operative agricultural machinery and implements societies;

5. Extensions of servicing workshops and retail stores; with a view to establish one servicing centre for one revenue firka;

6. Extension of cheap electric power to the villages.

In the 3rd stage: of development, in addition to further extensions to the items of the above two stages.

1. Increased activities of the State Extension Service;

2. Establishmet of Factories to manufacture, dairy, poultry and other appliances of the farm;

3. Establishment of factories, to manufacture the Tractor and other machinery requirements of the small holdings;

4. Extension of the retail stores and servicing stations to form a net work and there should be one such station for every group of five villages in the State.

Role of Plant Breeding in a Scheme of Maximising Production of Crops

By

M. B. VENKATANARASINGA RAO, B.A., B.SC., (AG.)., A.I.A.R.I.
Paddy Specialist

Introduction: The ultimate aim of all work on crop improvement is the production of the best crops, the chief test of superiority, implying, besides, the greatest return to the grower. This, in turn, is dependent upon the increased yields realised and the economics of production.

Although a good many of the crops now made use of for food and clothing for man and fodder for cattle have been in existence from very remote times, recent studies have shown that there is still a great scope for improving them by producing varieties that are more efficient in their use of plant nutrients, give the greatest return of high quality produce per unit area in relation to costs of production, besides a greater immunity against diseases, insects pests and adaptability to the needs of the grower and consumer. In achieving these ends the plant breeder has played a very large role.

Breeding—Art or Science? Whether plant breeding is a science or an art is still a subject of controversy. Many still hold the opinion that breeding is an 'art'. But that breeding is also scientific can be seen from the large number of achievements made since Mendel's principles of genetics have been applied to the improvement of plants and animals.