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ECONOMICS OF MECHANISED AGRICULTURE

by

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Indian economy is predominantly agricultural, nearly 70% of her population being dependent on agriculture for their sustenance. Any analysis of the economic conditions of India must, therefore, be based on a study of her agriculture, and any plan for her economic development must take the improvement of agriculture and its organisation as the starting premises. West Bengal, with her shrunken borders and the presence within them of a disproportionately large industrial area in and around Calcutta, is not an exception. One Calcutta swallow would not make an industrial summer in the land.

I

Poverty of the Indian economy has been talked of so frequently as to appear almost platitudinous. In the ultimate analysis it only reflects the poverty of India's agriculture, its low productivity. Agriculture in India, though it remains the main occupation of the people, does not produce nearly enough for home consumption, not to speak of developing an export surplus. Even with the present low calorific intake in India the annual deficit is about 2 million tons of rice and 1 million tons of other food-grains, and it is estimated that India will have to spend over Rs. 100 crores of foreign currency for the import of food-grains in 1949. The first requisite for a sound national economy for India is an increase in the productive capacity of her agriculture which can be brought about by a combination of two courses: (1) by extending the area under cultivation; and (2) by improving the yield per acre.

Let us first examine the possibility of extending the area under cultivation. The cultivated or cropped area in British India prior to the partition of the country* was 232.10 million acres excluding 47.45 million acres described as "current fallow". There was, in addition to these, according to Government statistics, an area of 153.59 million acres designated as "cultivable waste". The question as to how much of these "current fallows"

* Agricultural statistics for the Indian Union after Partition, including those for the States that have acceded to it, are not readily available. The Indian Union has taken over 77·7% of undivided India's population, 73·1% of her total land surface and 72·5% of the cropped area. The cross-section of the Indian economy, therefore, remains much the same even after Partition, and a study of per-Partition figures may not give a different clue to the problem in view.

were capable of being brought under cultivation by the application of scientific methods and machineries had yet to be answered. The fact that these areas remained uncultivated in the face of increasing pressure on the available lands would at once suggest that much of them would not be amenable to crop cultivation by the ordinary means. Even supposing that the whole of such "fallows" and "wastes" could be brought under cultivation, the maximum area of land that could be sown would amount to 433.14 million acres. This would work up to 1.48 acres of gross cultivable area of land per head of population as compared with an average of 2 to 2½ acres in Europe and America.

The position in this respect may be re-stated with reference to more recent statistics available for a particular part of the country, namely, the West Bengal province. Out of a total surface area of 18.9 million acres in the province, the net cropped area is estimated at 9.4 million acres, or just below 50%. This compares favourably with the figures for India as a whole in which case the proportion of net cropped area is only about 38%. Besides the above estimate of the net area cropped, there are in this province "current fallows" 1.9 million acres in area and "cultivable wastes" measuring another 2.8 million acres. The gross maximum of cultivable lands would thus come up to 14.1 million acres or roughly about three-quarters of the total land surface of the province. This proportion for India as a whole is estimated at 65%. But even then West Bengal with her very dense population, (21.2 million according to the 1941 census) would have only 0.7 acres of gross cultivable area per head of her population, i.e., less than half of the figure for India as a whole. It is thus clear that the *extensive* elasticity of agriculture would not bear much stretching and the limits are reached that way at a per capita acreage much below the normal prevalent in the advanced countries of the world.

Increase in agricultural productivity has therefore to be sought for largely on the *intensive* side; and here there is obvious scope for improvement. A remarkable illustration of the possibilities of intensive cultivation was furnished by pre-war Japan which supported a population of nearly 60 million on a cultivated area of barely 17 million acres, which came to less than a third of an acre per head. Intensive agriculture can be pursued, firstly, by increasing the area under multiple crops, and, secondly, by increasing the yield per acre on a single sowing. There are large possibilities of improvement on both these counts. Out of 232.10 million acres of net area sown with crops in pre-partition British India only 34.92 million acres or a little over 15% grew more than one crop in a year. The corresponding figure for West Bengal is even less, being only about 10% of the net cropped area of 9.4 million acres. It is possible, with the aid of scientific equipments, to extend the area under multiple crops.

The yield per acre on a single sowing is also pitifully low as will be evidenced by the comparative figures below:

	Yield per acre of land sown under rice.	Yield per acre of land sown under wheat.
U.S.A.	2,112 lbs.	973 lbs.
U.S.S.R.	2,668 lbs.	1,728 lbs.
Japan.	2,767 lbs.	1,508 lbs.
India.	1,357 lbs.	652 lbs.

One obvious cause of the low productivity in India is the lack of irrigation facilities and a fatalistic dependence on the not-too-steady monsoons. The incidence of damage caused by wild animals, locusts and other pests is also not inconsiderable. Most agronomists, however, would attribute the chief reason for low productivity to inefficient tillage and under-equipment of the agriculturists. In an age when science has provided developed methods of agriculture in the advance countries of the world, the Indian peasant plods through with his age-old plough and his rickety pair of animals trudging across the field and turning feebly as they go. The fallows and the wastes that be-spatter the lands and refuse to yield to the plough can be made to break their shells only when countered by bull-dozers ready at the job. Judged from a purely productive point of view the substitution of mechanised methods in the place of the present primitive ways seems already overdue.

II

The productive advantages of mechanisation have been amply demonstrated by the history of agricultural development in all the advanced countries of the world, more especially in the U. S. A., Canada and the U. S. S. R. In the U. S. A. a labourer who formerly ploughed one acre of land with a pair of horses is now able to account for twelve acres a day with a gasolene-driven tractor. By this quickening of agricultural practices, the human labour required is minimised. As a result while the volume of production has undergone considerable increase in U. S. A., (due to the use of new machinery and methods), the number of people engaged in agriculture has remained stationary since 1900. All increases in population have been effectively drawn off to industrial pursuits and thus contributed to the growth of the U. S. A. as the industrial leviathan of the present day world. A more recent and more spectacular development in the mechanisation of agriculture has been brought about in the U.S.S.R. after the Revolution of 1917. Before the first World War there were 20 million peasant farms on the present territory of the Soviet Union. They cultivated the soil with the most primitive implements, a census of which taken in 1910 counted 10 million wooden ploughs and 17.7 million wooden harrows doing the job. With this equipment, Russia collected an average

harvest of 65 to 80 million tons of grain in a year in the pre-Revolution days. The whole condition of Russian agriculture, however, was changed by state decree which stamped down the primitive and laborious methods of cultivation in small detached peasant farms, and introduced large scale farming and mechanisation in their stead. Particularly with the spread of collectivisation after 1929 the whole countryside became strewn with large-size farms, equipped with the most efficient machinery. By 1938, the place of the 20 million peasant farms of the pre-Revolution days was taken by 243,300 collective farms and 3,957 state farms which among them accounted for 99.3% of the total sown area in the country. In the place of the wooden ploughs and harrows were now employed 483,500 motor tractors aggregating 9,256,200 h.p., 153,500 harvestor combines, hundreds of thousands of tractor-drawn ploughs, seeders, compound threshers and a host of other farm implements of the latest type. The net result of this mechanisation was that by 1937 the agricultural output of the U.S.S.R. became double that of 1913 and grain production alone increased by 70 per cent, reaching the figure of 120.2 million tons.

The Indian cultivator, by contrast, uses a wooden plough that merely scratches the soil. He cuts his harvest crawling across the fields sickle in hand, threshes the grain under the bullocks' feet and winnows them by the sole agency of the wind. No wonder that this primitive process should bring in a poor return. The case for mechanisation is unassailable if greater productivity is to be attained. The need for intensive cultivation in India is undoubtedly great and any programme of intensive cultivation must include a rehauling of agricultural equipments. It must not be supposed, however, that an automatic change of agricultural methods is immediately feasible, or that the introduction of mechanised agriculture would be an easy process. There are important limiting factors and material hurdles to overcome before India can resort to mechanisation. The most formidable snags are in the size of the agricultural holdings in India and the conditions of rural employment. It is necessary to study the full implications of each of them.

Mechanised agriculture presupposes a sizeable holding for its operation, and there is always a minimum limit below which the application of machinery would be uneconomic. Mechanisation and large scale farming go hand in hand. Collective farming in Soviet Russia, a conspicuous example of planned mechanisation of agriculture, has struck an average of 1600 acres for a farm. The size varies widely in different regions. It is below 600 acres in the Ukraine and is twice or there times this size in the lower Volga region. For a 40 h. p. tractor to remain usefully employed for 2000 working hours in a year—for, that is its optimum economic use—a minimum size of 200 acres for a cultivable unit is irreducible. It is hardly possible profit-

ably to employ machinery and modern scientific methods on farms of a smaller size. And it is precisely here that the present conditions in India are most unsuitable. Thanks to endless sub-division and fragmentation peculiar to the peasant holdings in India, the size of the average agricultural holding is too small even for the economic employment of the present primitive equipment. A cultivator's holding in the Gangetic plains of Bengal, Bihar and the U. P. comes to even less than 3 acres on the average. Fragmentation, again, is a normal accompaniment of division of property according to the existing laws of inheritance in the country, so that very few of these meagre holdings are in one compact block. Three to four plots per holding is the usual phenomenon. These plots are sometimes so small that it is scarcely possible to turn the bullocks round while ploughing.

As has been stated above, introduction of mechanised agriculture on anything less than a stretch of 200 acres of land would be uneconomic, and in the present state of agricultural holdings in India it would require drastic measures of land reform to make the units economic. Consolidation of holdings has been attempted in the past, firstly, by co-operative pooling as in some parts of the Punjab; and, secondly, by the various Consolidation of Holdings Acts in the different provinces. But the total effect has not been anything more than merely palliative. Co-operative efforts, without the requisite co-operative spirit and with no commensurate advantages accruing therefrom, were perhaps blighted from the very beginning; and provincial legislations for consolidation have also been largely unavailing. In the Central Province where the Consolidation of Holdings Act of 1928 bore the most success, the holdings of nearly 1,00,000 cultivators covering an area of about 1,33,000 acres split up into 2,433,000 plots have been consolidated into 361,000 compact plots. Even then, the average area of a plot remains slightly more than 3 acres apiece.

It is clear that no tinkering can bring about the minimum economic size of 200 acres a block necessary for mechanised farming. Some people have naively spoken about the Danish legislations which saved farms from being divided into small strips, by a series of Acts of Parliament dating from the beginning of the nineteenth century, prohibiting the subdivision of farms below a certain size. The application of the Danish Acts would not, however, improve matters in India. They can only prevent further subdivision and fragmentation and cannot undo by mild corrective measures the accumulated evils of centuries. The task of consolidating "dwarf holdings" in India into economic units would require more drastic legislation and much else besides. The exigencies of planning would enjoin a somewhat ruthless scrapping of the land system in India and facing its consequences with courage and determination. Merely scrubbing the

surface with mild and inoffensive measures can hardly be expected to avail. The basic necessity is to maximise agricultural production, if the national economy is to be raised to its due level; and much of the dead weight that clings to the body-economic has got to be deliberately removed.

Now, supposing that legislation brings into existence the economic farm where upon it would be possible to employ mechanised methods of cultivation, a logical consequence of far-reaching importance to the rural economy is likely to follow. Agriculture in India, with its present primitive organisation and slow methods, hardly keeps the agricultural labourer engaged for more than four to six months in the year. Even then, India maintains 70% of the population on the earnings of this precarious occupation. Any attempt to rationalise agricultural production by the introduction of labour-saving machinery on compact blocks of lands would throw out of employment a large number of the present agricultural population. For, mechanised agriculture can usefully employ only a small fraction of the labour force now subsisting on lands. An economist's estimate in the Soviet Union computed that, if agricultural production in the country could be organised as efficiently as that on the state farms, working at a high level of mechanisation, the 26 million peasant households in the land comprising 100 million of people could be displaced by an army of 1,200,000 agricultural labourers. Similarly, on a modest estimate, the man-power requirements of agriculture in India after mechanisation on the not-too-large 200-acre farms would not hold more than a quarter of its present labour force. Viewed from the social angle this capacity for rapid and rationalised production is a great gain to humanity. But the resulting unemployment in the villages would require to be offset by comprehensive planning for the utilisation of the man-power so released.

Industrialisation is often enough cited as a handy valve for drawing off all surplus labour the country can provide. But the transition is not likely to be easy, nor would it be self-adjusting at that. Large scale industrialisation, with commensurate capital equipments, would not be feasible except on a long term basis; and a redistribution of population between urban and rural avocations would not automatically come about. Meanwhile, one of the most important avenues of employment for the surplus population would be secured by the development of small scale and cottage industries in the villages. Organisation of diffused rural industries on the lines of the Induscos (industrial cooperatives) in China can be expected to contain the process.

III

It is now necessary to gather up the loose ends of the conclusions reached in the foregoing paragraphs. Poverty of the Indian economy reflects the poverty of India's agriculture, the low productivity of which is

mainly attributable to the primitive equipment of the cultivator operating on an uneconomic holding. The remedy lies in the application of mechanised methods of cultivation prevalent in most advanced countries. There are, however, important factors inhibiting the introduction of mechanised agriculture, the chief among which are, firstly, the economic size of the cultivable unit; and secondly, resultant rural unemployment consequent on the rationalisation of agriculture. Mechanisation of agriculture being considered a basic necessity for the economic development of the country, the inhibitions noted above must have to be remedied and suitably overcome instead of being magnified as insurmountable barriers. The size of the agricultural holdings must needs be increased to a minimum of 200 acres in a block so as to enable the machines to operate with advantage; and drastic legislation may be necessary to bring that about. The problem of rural unemployment threatening any attempt to rationalise agriculture may be countered by organising and developing rural industries on small scale co-operative lines. There are also other handicaps in the process of mechanisation in that India will have to be dependent on others for the supply of agricultural machinery and of the power resources for working them. The dependence on the first count is remediable with a suitable development of a machine industry in the country. The example of the Soviet Union may serve as an encouragement. Till the early thirties she was importing agricultural machinery from America, but she has now become a producer of these machines herself on a scale exceeding that in any other country. India's dependence on import for the supply of power-fuel is also capable of being circumvented by the ingenuities of scientific development.

Application of mechanised methods is expected to bring in other improvements in agricultural technique, notably in the sphere of irrigation, land-reclamation and the prevention of soil erosion. The present dependence on the monsoons as the only irrigator of crops can be obviated by a more scientific approach. Artificial irrigation by the construction of canals, tanks and wells would ensure a steadier supply of water necessary for the proper germination, growth and the maturing of the crops. The possibilities of pump irrigation are also not inconsiderable; and the exploitation of subsoil water by electric lift would be an additional means of irrigation by mechanical means. For land-reclamation purposes, the tractor, besides providing the mechanical plough, would be useful in extending the area under cultivation. A substantial portion of the wastes and fallows can be brought under crops only after smoothening hillocks, filling in depressions and gullies and eradicating deep-rooted weeds. All these operations are beyond the scope of the plough and the bullock power and would require mechanical appliances to aid them. The prevention of soil erosion is also another aspect of scientific agriculture. Besides mecha-

nical fertilisation, contour-bunding and terracing, regarded as very effective means of conserving the soil, can be done by mechanical methods with the help of self-propelled graders and terracers.

Mechanisation of agriculture would bring in its train a detailed reorganisation of the economy of the land. The introduction of machinery into agricultural operations would require rural establishments for servicing them. Dissemination of technical education in the villages and the building up of a large cadre of skilled operators would impart an industrial bias to the country-side. The organisation of rural industries, supplementing the agricultural economy, would be a fitting finale to the growth of mechanised agriculture in the villages. To quote the Report of the Royal Commission on Agriculture in India, "It is essential that all the resources at the disposal of the State should be brought to bear on the problem of rural uplift, if the inertia of centuries is to be overcome."

NOTES ON ECONOMICS OF MECHANISATION OF AGRICULTURE *

by

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The Mechanical Cultivation Section of this Province is operating 108 tractors in 41 districts of the Province. Tractors are allotted in units of 4 to 7 according to demand from the districts.

Upto the end of October 1948, the Section has carried out the following agricultural operations:—

Deep Ploughing	26,331 acres
Shallow Ploughing	75,864 acres
Harrowing	5,842 acres
Grading	1,509 Hours
Bunding	106 Hours
Terracing	199,614 Feet

Activities of this section have been confined to deep ploughing work for eradication of weeds and reclamation of waste lands. Shallow ploughing work is undertaken only when deep ploughing work is not available.

Economics of Mechanisation of Agriculture :

Economics of mechanisation of agriculture largely depends on the purpose for which mechanical means are used in agriculture. In my opinion,

* The views expressed in this note are those of the author only.

there are two purposes for which tractors and allied implements are used in agriculture:

(1) Deep ploughing work of eradication of weeds and reclamation of waste lands.

and (2) Seasonal ploughing, which is normally done by bullocks.

Economic success of mechanisation depends on (1) Concentration of work (2) Maximum period for tractor operation in an area in a season and (3) Minimum wastage in movements. Deep ploughing work in some areas in Karnatak and West Khandesh almost gives these ideal conditions. Tractors in Karnatak are employed from October to April on weed eradication work and from May to 3rd week of June on seasonal ploughing. Comparatively larger holdings in Karnatak give better ploughing result with tractors. In my opinion, this type of work, which is in the interest of cultivators, should be enforced on cultivators by law by which cultivators of *harihali* infested areas must get their area tractor ploughed at their own cost. This would not only offer large area for tractor ploughing, but clearing of *harihali* infested lands "en block", would control this obnoxious weed to some extent.

Employment of tractors only on seasonal ploughing, either by Government or private agencies, in areas which are entirely reliant on monsoon is not a sound economic proposition. Normally, the ploughing season, in such areas, is short and the requirement of cultivators, during the season, cannot be fulfilled unless a very large fleet is maintained in that area. Use of such large fleets, which are kept idle for a major part of the year results in heavy overhead expenses. This can be minimised to a certain extent, if units of 2 to 3 tractors are handled by a large number of Co-operative and Multipurpose Societies in such areas. These tractor units, with power attachments, etc. can be employed for pumping, thrashing and transport purposes during slack season. Tractors in irrigated tracts can be employed on seasonal ploughing practically throughout the year, and in my opinion, tractor ploughing in areas like Belapur-Kopargaon, can be undertaken as a successful commercial enterprise.

Future of Mechanisation of Agriculture :

From my personal experience, I find that it is not possible to introduce mechanical cultivation in every district of the Province. Some districts are very enthusiastic about it, but economic running of tractor units in such districts is not feasible, due to (1) small holdings, and (2) very short season of ploughing. Mechanical cultivation has got a bright future in the following districts—Ahmedabad, Broach, Poona, West Khandesh, East Khandesh, Bijapur, Belgaum, Dharwar, Ahmednagar, Sholapur and Nasik. Other districts are unable to fulfil the minimum requirements for successful mechanical cultivation. In my opinion, the organisation of Mechanical Cultivation

Section of a Province should not be on district basis, nor the units operating in districts, but should be treated as permanent allotment to the district. Tractor units should be mobile and should operate according to demand of the public. The size of tractor units in this Province should be of 6 to 8 tractors and each should be a self-contained unit for repairs, maintenance, etc. Government tractors should operate in the reclamation and eradication of weeds only and seasonal ploughing should be entrusted to private bodies, where feasible.

Here, I may discuss some points which are intimately connected with the future expansion of mechanical cultivation in this Province.

1. *Handling of tractors by private bodies :*

This question has been discussed every now and then. In my opinion, successful operation of tractors by private individuals can be encouraged if some obstacles in achieving this are removed. Firstly, technical assistance to tractor owners is not satisfactory so far. Sometimes the owner has to keep his tractor idle as the required spares are not available. Secondly, it is desirable that the persons directly connected with operations of tractors should have certain technical training to supervise the successful operation of tractors. This would eliminate to a great extent their reliance on unscrupulous drivers. Thirdly, the required quantity of oils and lubricants to the owners should be guaranteed by the Government. In short, Government should give every assistance to tractor-owners, either Societies or individuals, which would facilitate operating of tractors without any difficulties.

2. *Light tractors Vs. Heavy tractors :*

Another question is whether it is advisable to use a large number of light tractors or a small number of heavy tractors. The argument in favour of using a large number of light tractors is that, in the event of casualty to any tractor, percentage of efficiency of the whole unit is not affected to a large extent and secondly, capital cost is much less. As against this, overhead charges, compared with heavier tractors for the same capacity, are heavy. It is not the scope of this note to go into details of this controversy, but this question should be dealt on agronomical features of the areas in which tractors are to be used. For example, it is advisable to employ lighter tractors in Konkan districts where individual holdings are small. But where conditions are favourable, like large holdings, I have no hesitation in employing heavier tractors.

In conclusion, I would like to add that mechanical cultivation in this Province has a bright future, and its application on a large scale would implement "Grow More Food" campaign of Government. In my opinion, the scope of mechanical cultivation should not be complete replacement of bullocks or manual labour, but these mechanical means should be supplement to our meagre resources.

MECHANISED CULTIVATION IN ASSAM

by

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Introduction:—The severe food shortage during the World War II drew the pointed attention of the Government of India to accelerating food production in the country. Several schemes under the Government of India were taken up and the province of Assam also contributed its best to the Grow More Food Campaign.

To fight with the pressure of growing population and poverty of the land, the Government of Assam initiated schemes for immediate increase of food-grains by issuing improved seeds and manures to cultivators at concession rates. Irrigation facilities were also provided by small Irrigation Project Schemes in which Government contributed half the cost.

With a view to extending the area under cultivation the Government of Assam initiated schemes to open out reserves for cultivation, but there were certain limitations to the undertaking due to dearth of labour and lack of funds on the part of cultivators. The Provincial Government then proposed to form co-operative bodies and extended their help to these bodies with tractors and implements purchased out of the Government funds.

Scope for extension of area under crops:—The Province as a whole provides for enormous possibilities of extension of cultivation in fertile and virgin lands hitherto left uncultivated. Financial resources of the people in general, in fact, are very much limited and additional investment for purchase of up-to-date implements for employment in agriculture is out of question. The Government have therefore chalked out plans to help the cultivators, who form the backbone of the nation, by way of providing for improved implements for cultivation.

Methods of work:—Due to existence of innumerable small holdings, there was little or no chance of mechanised cultivation by individual cultivators and the Provincial Government made a timely attempt to allow the people to form groups in the shape of co-operative bodies and get the help extended by the Government in supplying tractors and implements at scheduled rates of charges for ploughing and harrowing their lands. The question of big holdings is dealt with separately.

Scope for maintenance and repairs of machinery:—With a view to maintaining the Government's machinery employed in agriculture and helping the

farmers in their individual efforts to employ machinery in agriculture, the Government have decided to establish a central workshop and two mobile work-shops where all facilities for repairs and maintenance of all types of agricultural machinery will be available. Strict vigilance will henceforth guard farmers against introduction of machinery at random in agriculture and advice will be available from the Department of Agriculture free of cost.

Reclamation of land:—Heavy tractors are being used in reclamation of land providing only medium depth of ploughing, protecting the land against heavy erosion at the very outset. Bull-dozers are proposed to be employed where necessary to clear out light forests and graders on highly undulated lands. It is also proposed to put in contour bunds for safeguarding against erosion wherever necessary. The Brahmaputra Valley provides enormous scope for extension of land under crops due to its good natural drainage system.

Mechanised cultivation of arable land:—Due to shortage of labour, cost of agricultural operations has increased enormously and it has become almost impossible for ordinary farmers to complete operations timely. Natural calamities and inequitable distribution of rainfall are also greatly responsible for untimely operations in agriculture and subsequent damage of crop or poor outturn. For various other reasons as well it has so happened that the time available for agricultural operations for almost all major crops in the land, has become very short. During droughts, the surface of the soil is hardened up and the ordinary country ploughs are unable to penetrate into the soil until showers set in. Immediately after the monsoon breaks, there is hardly any time for cultivation and growth of plants; the first flood washes off the land and premature crop plants and cultivators are left to their fate.

Apparently the time factor became a problem in cultivation and the Government contemplated employing machinery for quick operations and increasing outturn through better cultivation.

Operation in centres: The Department of Agriculture has during the very short period of about 6 months, opened up 8 projects in Darrang, Sibsagar, Lakshmipur, Cachar districts in the province, most of which are for reclamation work. Obviously the task of organisation and operation of the projects is very hard due to the fact that the spirit of co-operative farming amongst the farmers has still to be infused. The Government after a long effort of about 3 to 4 years procured some machinery through the Government of India and have managed to open up some centres which are still very negligible in comparison with the work available for agricultural improvement in the province.

Conclusion: Due to various insuperable difficulties in obtaining tractors and implements, no start earlier than 1948-49 could be given. During

the year upto 31st October, 1948, about 27,000 acres of land have been cultivated and operations in different centres are progressing as rapidly as can be arranged, inspite of the fact that machinery and parts are not yet available through the usual trade channels.

Circumstances permitting, the Government desire to add to the existing area a target figure of about 5,000 acres of land during 1948-49 and make similar additions annually till the Province is abundantly self-sufficient and even surplus in respect of food production.

We are not yet in a position to collect data in respect of working costs etc. of which nothing was done in the Province previously. Circumstances have compelled the Department to take up this work in hand and we hope to collect data gradually when actual work has progressed to certain extent. Sufficient experiment in the line has been conducted in different parts of India and the Government of Assam propose to have some tangible work done without devoting time only for experiments as the food position in the whole of India is extremely alarming. It is expected that the Province will be able to show some definite work in the near future.

ECONOMICS OF MECHANISATION OF AGRICULTURE.

by

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Economics and scope of 'Mechanised Agriculture' in India is yet a confused and controversial issue owing to the absence of a specific and uniform meaning attributed to the phrase. If some take it to mean improved farming, others regard it as 'ploughing, harvesting and other operations by a tractor and machines as against the country means—the plough and the sickle.' An important official emphatically replied to a question of mine—"If India is to live and prosper as a respectful State in the Comity of Nations it has but to mechanise; for all prosperous countries of the West have had to mechanise agriculture first." More emphatic was the gentleman's reply when called to explain the effects of tractor cultivation on the crop yield—"Our implements work the soil only a small depth of four to five inches while a tractor will till eight to ten. A plant, thus, in the tractor operated soil draws on double the area and you can well imagine without another argument, the yield that would result." It is not only a case of individual thinking but unfortunately a good percentage of people think alike out of sheer ignorance. A wrong notion has entered into currency that, America and Russia have advanced because of mechanisation and the panacea for India too lies in getting her agriculture revolutionised by mechanisation. We forget

the entirely different sets of conditions existing in India to-day and those which existed in America and Russia before they mechanised agriculture. Yet, we are not to be left behind in the race of nations for scientific improvements. We have to fit in things in our own frame work, for the frame work itself is far more resistant, without, of course, doing it irreparable harm. The use of bullocks in farm husbandry is said to be a sign of backward farming, but it is not always true. We have also to be cautious of the powerful and well directed propaganda (of the large financial interests concerned in the sale of implements) to strengthen such belief.

To conclude that mechanisation will lead to increased employment, based on the instance of use of power pumps in Coimbatore district of Madras, which has led to the intensification of agriculture in the area by making water available from very deep level, is hardly applicable in general. The difference between employment creating and employment reducing effects of farm machinery is important to recognise in order to have a proper appreciation of the effect of mechanisation on employment. Opening up of the uncultivated land, reclamation of the culturable wastes, draining of the marshy lands, provision of adequate irrigation facilities and such others may be unenterprising by mannual and bullock labour; but the use of machines in these directions is sure to open up new avenues of employment to the already idle hands. Also, the seasonal labour shortages may be met profitably by the use of machines which will only supplement the human labour. But complete replacement of labour by tractors for cultivation is an example of employment on the farm being reduced by the use of machines.

The term farm mechanisation is not used today in the limited sense of use of machines for tillage operation, harvesting and threshing of the farm produce but includes power lifts for irrigation, trucks for haulage of the farm produce, processing machines, dairy appliances for cream separating, butter making, oil pressing, cotton ginning, rice haulling, and even various electric home appliances e.g. radios, irons, washing machines, vacuum cleaners and hot plates. It is another factor which leads to difference of opinion about its scope as different individuals have different aspects of mechanisation in mind while discussing it.

It is therefore, necessary to mention that the term mechanisation of agriculture has been used in the widest sense in the following discussion. Even then it will be wrong to treat it as a special agricultural technique leading to increased yields. It is hardly anything more than a labour and time saving device. The only proper way of looking at it is with reference to the respective economies possible by it in comparison with other alternatives for performing a certain agricultural operation. Laying down the criterion for the use of machines in agriculture, Dauson remarks that in countries where machines are cheap, while labour is expensive and, moreover, of a type qualified to understand and care for them, a free use of machines is indicated, and

the introduction of labour saving implements will generally result in a direct saving of outlay; even if it does not, the additional expense is so small and the need for economy in labour so great that its use is economical. If we apply this criterion to India we find the machines are expensive as they are not manufactured in the country, fuel is costly, labour is cheap and unskilful in the use and care of machines. It follows that the extent to which the labour saving implements is an economy is much more limited here than in U.S.A. or other western countries.

However, there can be no two opinions on the urgency of mechanised help for increasing production where it creates further employment or does not compete with the bullock and human labour i.e.:—

1. Mechanised irrigation—provision of tubewells, power pumps, etc. In India with so erratic a monsoon, the field for them is unlimited, particularly in view of country-wide hydro-electric projects.
2. Breaking up of new lands.
3. Eradication of pernicious weeds for cultivation.
4. Draining of the marshy lands.
5. Mechanisation in sparsely populated areas owing to unhealthy climate.
6. The use of machinery in meeting the seasonal shortages of labour in order that operations may be timely.
7. Miscellaneous—contour ridging, embankments, village roads, drainage and irrigation channels, etc.

SEASONAL SHORTAGES AND TIMELINESS OF OPERATIONS.

The issue of mechanised help during seasonal labour shortages is not so simple and clear cut. Shri Mayadas, Director of Agriculture, U.P. recommends the use of harvester thresher combines and tractors. The advantages claimed by him are:—

1. Quick harvesting of crop—a safeguard against inclement weather conditions.
2. Land available for producing second crop of peas and gram after rice.
3. Hot weather cultivation after rabi harvests.
4. Raising of early green manure or fodder crops on fields ploughed during summer.
5. Release of bullock and human labour for hot weather cultivation, growing second crops and more thorough cultivation, in case tractor cultivation is not taken up,
6. In case of tractor cultivation:
   (a) deeper cultivation in sugar cane areas.
   (b) quicker preparation of seed-bed and rapid harvest on vegetable farms.

The tillage operations may be performed with bullock-drawn implements as efficiently as with a tractor, but there is no doubt that mechanised appliances effect considerable economy in time and thereby minimise weather hazards. Performing of agricultural operations in time is of considerable importance in Indian agriculture as the intervals available for preparation of seed bed and sowing khariff crops is often very short and delay, even of a few days in sowing, is of material importance in determining the stand of the crop and finally its yield. Similarly in rabi preparation, particularly where sowing is dependent on stored rain moisture in the field, the area sown, germination and the successful growth of the crop depend on how quickly the farmer is able to finish the sowing operations on his holding because the land loses moisture fastly during that period. Weather hazards during harvesting and when the produce is on the threshing floor also considerably effect its quantity and quality. It, therefore, cannot be denied that indirect influence of mechanised farming on yield in this respect will not be insignificant.

It is, therefore, necessary to launch a few pilot projects in selected areas. The projects must study the complete economy of the area under them and minutely observe the effects of mechanisation on agriculture both on a short and long term basis.

Shri Maya Das believes that, as a result of introduction of harvester thresher combines alone and consequent release of bullock and human labour for their efficient cultivation, the increase in rice production would be about 2 million tons and about the same in wheat and barley in U.P. alone i.e., an increase of 4 million tons, the present overall target of increased production of food-grains in the whole of India to be achieved in five years. It raises a number of technical issues which need to be experimented upon i.e., the effect of quick seed bed preparation on the soil structure and its susceptibility to erosion, double cropping and its effect on the total yield, adequacy of canal water to meet the extra demand for irrigation, effect of hot weather cultivation in increasing yield, etc. The existing data regarding these are hardly adequate for drawing conclusions. Experiments on double cropping carried out in certain tracts show decrease in rice or wheat yields when compared with their sowing after fallow. There are other difficulties in the way. How are we going to enforce a limit that such machines would function only as supplementary to existing labour force and would not replace them? How is the present land organisation of innumerable small holdings to be fitted in with collective harvesting and without overhauling itself into co-operative joint farming, collective farming or individual holdings of atleast 8 or 10 acres? Can the agricultural economy bear the strain of maintaining both bullock power and machines?

PRESENT SCOPE

Then we come to the issue of farm mechanisation in the sense of tractor cultivation and harvesting and threshing with machines on land already under cultivation. Two questions suggest themselves:

1. Will it be practical wisdom to mechanise our agriculture immediately?

2. Should mechanisation be our long term objective?

As regards the first question, probably, the answer is easy. Even if it is desired to mechanise agriculture immediately it is not possible for reasons given below:

(a) Lack of tractor and machines:—The tractor requirement of India including Pakistan of all types and sizes is estimated at 15,800,000 while there is a world shortage of tractors and agricultural machines. It is not possible for the manufacturing countries to meet even a fraction of our needs.

(b) Lack of cheap fuel:—Cost of petrol is 4 to 5 times higher in India as compared to other countries with mechanised farming. The output of energy per capita, per annum, or 'energy index', is 300 units for an average American whereas it cannot be more than 90 units for an average Indian. Out of 7 la'khs of villages in India only 1,200 have electric service of any sort. According to Dr. N. G. Chatterji, we consumed in 1937-38 only 326 million gallons of liquid fuel of all kinds of the total value of nearly ten crores of rupees of which only 76 million gallons were produced in this country. The consumption of petrol in India is estimated at 180 million gallons of which only 18 million gallons are produced in the country. The consumption of liquid fuel per head is less than a gallon as against 50 gallons in U.S.S.R. and 25 in the U.K. This consumption is likely to go up by 5 to 8 times its present figure with the growth of industries and improvement of roadways. It will require either the import or the manufacture of liquid fuel to the extent of 60 crores of rupees. If we add to it the requirements of mechanised agriculture, we can well imagine the enormous quantities of fuel requirements and our dependence for it on other countries. Dependence for fuel on foreign countries for strategic reasons may prove the strongest point against future mechanisation of agriculture in India and may have to be given up in the interest of national security unless the countries of the world or the U.N.O. is able to secure by effective mutual agreement, a guarantee of world peace against aggression and elimination of war from the face of this earth.

(c) Lack of necesary capital:—The Indian farmer in a deficit agricultural economy is proverbially poor. Instead of having any surplus with him for purchase of machinery he has a crushing burden of debt, the total value of which has not shown any decrease in spite of such high agricultural prices.

Persons with holdings over 8 acres have no doubt lightened their burden of debt but those below it, who far outnumber the former, have not received any relief.

(d) Lack of necessary skill and machine-mindedness together with inadequate workshops and repair service:—In this connection Moore observes, "A deterrant to mechanisation in many tropical regions is the lack of understanding on the part of the people of how to select, operate and maintain machinery at a high level of efficiency. To meet all the machine repairs and difficulties that arise in the normal operation of farm machinery requires considerable training and understanding.....Many practically new articles are lying idle throughout the tropics, broken and unused, because they were attached to too heavy a tractor; on the other hand, many new implements are unused because the farmer has insufficient power. I have seen practically new tractors standing idle for months awaiting the arrival of simple repair parts."

(e) The existing land system is based on bullock economy and is characterised with innumerable small holdings. The holdings to be organised into economic units will take time. Full economy of mechanised agriculture can be realized only when the farm unit is large enough to fully utilize a minimum unit of machines. A Montana Study (U.S.A. 1933) indicates that there are atleast three reasonable efficient sizes of one man wheat farms. The smallest one man 3 plough tractor farm has an optimum acreage of 800 acres, one man 4 plough tractor 1,100 acres and for one man 6 plough tractor the optimum size is 1,800 acres.

(f) Lack of machines suiting our requirements:—There is a great need of research to design machines and implements suited to our soil, climate and farm economy. The foreign makes do not meet our requirements fully nor is our demand considered enough in volume to warrant researches by them for evolving machines suited to our conditions. This work will have to be taken up by our national Government.

(g) Displacement of existing labour and population from agriculture:—It has ben estimated that even under existing bullock economy 10% of the workers were surplus on the basis of population, in 1941. In case of mechanised farming, 77.5% of the total workers i.e., 67 million workers will have to be provided for in other occupations.

According to Moore, "Unless employment is found in industry or in other agricultural requirements for such displaced persons they become unemployed and willing to work for small wages which in their turn make hand labour so cheap that it becomes uneconomical to operate machinery. This necessitates a return to hand methods of production. The break in this cycle from hand labour through mechanisation to hand labour if accomplished will result from the skilfully engineered application of the competence of economists, industrialists, engineers and sociologists."

FUTURE SCOPE AND ECONOMICS OF MECHANISATION.

Economic trends appear to favour meshanisation, though a vast majority is yet under-employed or unemployed. The reasons are obvious. We judge things by their economic worth. If a work can be done more cheaply by a machine, manual labour is sure to be replaced by it. And it happened in industries. The cottage workers had to search for their bread some where else. Mechanisation of agriculture too appears to be on the progressive path whether the country adopts a capitalist or a socialist economy. The only difference may be that in the capitalist economy it may lead to exploitation and unemployment whereas in the socialist economy, its use may be regulated so as to raise the standard of living, increase the leisure period and reduce drudgery of certain types of human labour or human and bullock labour combined. The transition, in fact, had already set in after the first World War. Country carts gave way to the trucks and lorries; power appliances took over the jobs of grinding, hulling, pressing and milling. If anything limited their spread in rural areas, it was their unavailabilty, the lack of power fuel and communication facilities. Also, with the arrival of cheap hydro-electricity, much more stimulus will be provided to the stationary type installations.

The position of the bullock in the agricultural economy is weakening every day owing to its multifarious functions being taken over by the power appliances. This has led to a shrinkage in the average number of working days, per pair, each year. Working days hardly exceed 120 on large sized farms employing more than a pair of bullocks while they are not even 100 on holdings below five acres which constitute the bulk, nearly 70% of the total holdings in India. As the work per pair of bullocks is decreasing with no decrease in their maintenance charges, the working cost per unit is constantly rising up. Their maintenance has become even more uneconomical these days owing to the existing high prices of feeds and bullocks have fallen short of demand inspite of increasing under-employment. There is also shortage of bullock power at present for cutivation needs as a result of the after effects of the last war. And, as the bullocks compete, in these days of acute food shortage, with human beings for land for their own fodder and feeds, their position is becoming all the more anomalous in our agricultural economy.

According to cattle census report 1940, there were 7.10 crore work cattle and 3.64 crore cows in India (Pakistan included). A very large number of cows are maintained not for milk but for breeding purposes only. With mechanisation, the number of such cows and of the work animal will be considerably reduced. In U.S.A. the shift from animal power towards mechanical power on farms, city, towns and mines, released 9 million crop acres since 1918. In India, though no land may be released for food crops

as the fodder crops occupy only 4.2% of the cropped area, it will surely relieve the pressure on existing supplies of cattle food which are quite inadequate as is evident from the following figures:—

	In Million Tons.	
	Estimated Annual Requirements of Cattle Food.	Available Quantity.
Green Fodder	381.0	169.1
Dry Fodder	227.5	135.2
Concentrates	75.5	7.5

This, in turn, will facilitate mixed farming on a larger scale in India. Besides an increased supply of protective foods so lacking in our diet mixed farming will ensure proper supply of farm yard manure even after the reduction in the number of work cattle.

In other countries with mechanised agriculture, because of meat eating habits, the male progeny of milch stock is easily disposed off. It will, however, be a ticklish issue here, with the disappearance of their needs for draft purposes.

We cannot ignore the other important phenomenon i.e., inspite of labour surplus statistically, there is really a growing labour scarcity for agricultural operations in India; caste taboos and other social restrictions are to be held responsible. This also gives stimulus to increased mechanisation of agriculture.

The following estimates of expenditures show the economies of tractor farming:—

The estimated expenditure on bullocks and labour on 60 acres and 250 acres farms.

Particulars of Expenditure	Amount in Rupees.	
	60 acres.	250 acres.
Wages of labour @Rs. 30/- per month per labourer.		
(a) For 18 labourers on 60 acres. ..	6,480	
(b) For 75 labourers on 250 acres. ..		27,000
Expenditure on bullocks @ Rs. 3 per pair per day.		
(a) 6 pairs on 60 acres. ..	6,570	
(b) 25 pairs on 250 acres. ..		27,000
Total working expenses.	13,050	54,000

Estimated expenditure in tractor farming.

Following set of implements would be required :—

		Rs.
(1)	One 30 H.P. Tractor	7,500
(2)	One two furrow plough.	1,100
(3)	One Disc Harrow.	1,200
(4)	One Seed Drill.	2,000
(5)	One Reaper.	1,200
(6)	One Thresher.	11,000
(7)	One four-wheel Tractor.	1,500
	Total ..	25,500

In the case of sugarcane cultivation one 'Two furrow mounted Ridger' and one raw crop cultivator costing Rs. 2,200/- would also be required.

If the cost of 30 H.P. tractor and set of implements be estimated at about Rs. 25,500/- for a farm of 60 acres and Rs. 27,700 for a farm of 250 acres and the working hours in cultivation, seeding, harvesting and threshing, etc. 600 and 2,500 respectively, the working expenditure would be as follows:—

PARTICULARS OF EXPENDITURE	Amount in Rupees	
	60 acres farm	250 acres farm
A. *Staff*:		
(*i*) One Tractor operator @ Rs. 80/- per month	960	960
(*ii*) One Tractor cleaner @ Rs. 40/- per month	480	480
(*iii*) Labourers @ Rs. 30/- per month.		
(*a*) 2 labourers on 60 acres farm	720	..
(*b*) 5 labourers on 250 acres farm ..	..	1,800
(*iv*) Dearness allowance at 20%	432	648
	2,592	3,888
B. *Materials* :		
(1) Power kerosene @ Rs. 1/8/- per gallon, per hour consumption being 1.8 gallons :		
(*a*) For 1,080 gallons on 60 acres farm ..	1,620	
(*b*) For 4,500 gallons on 250 acres farm ..		6,750
(2) Lubricating oil @ 1 gallon for every 35 hours @ Rs. 4/- per gallon :		
(*a*) For 17 gallons on 60 acres farm ..	68	
(*b*) For 71 gallons on 250 acres farm ..		284
(3) Grease, Sundries and spare parts at 10% of total investment on implements :		
(*a*) on 60 acres	2,550	
(*b*) on 250 acres		2,770
(4) Depreciation :		
(*a*) at 7½% on 60 acres	1,913	
(*b*) at 15% on 250 acres		4,155
(5) Interest at 3% :		
(*a*) on Rs. 25,500	765	
(*b*) on Rs. 27,700		831
	6,916	14,790
TOTAL WORKING CHARGES FOR 1 YEAR	9,508	18,678

The comparative costs of wheat cultivation per acre on mechanised and non-mechanised farms are given below:—

PARTICULARS OF EXPENDITURES	*Expenditure per acre in rupees.*	
	Non-mechanised Muzaffarnagar	Mechanised Bhadruk (Lucknow)
Machinery	X	55.56
Bullocks	113.73	11.37
Labour	69.13	22.20
Seed	12.39	19.00
Manure	64.87	2.00
Irrigation	13.06	19.53
Supervision	16.19	18.56
Land	4.69	10.00
Depreciation and interest on fixed capital.	9.13	10.00
Interest on Working Capital at 6% for 6 months.	9.10	5.13
Miscellaneous	1.70	3.00
Total.	313.99	176.35

It will be seen that the difference in the cost of cultivation on labour and motive power in case of mechanised and non-mechanised farms is Rs. 93.73 per acre.

The estimate of expenditure in case of tractor farming is made liberally and if it errs, it errs on the higher side; nevertheless, it is less by about Rs. 3,500|- when compared to the expenditure on 60 acres farm with bullock power. Ordinarily not more than 5% is allowed on total investment for repairs but the allowance made here is 10% owing to lack of operative skill and high repair cost in India, at present. It may also be added that this very set of implements is capable of managing a farm upto 250 acres the economy in expenditure being considerably higher in that case i.e., the initial total capital investment in machinery is nearly equal to the cost of 25 pairs of bullocks while the working expenditure on non-mechanised 250 acres farm is in excess by Rs. 40,950|-. Ferguson's study all over the world shows that replacement of animals by a tractor can increase income from 50 to 150 per cent according to the size of the farm. This simple economic factor is pressing large farm owners to replace bullock force with tractors which they can purchase with the sale price of their bullocks. A 30 B.H.P. Fordson tractor complete with set of tillage implements costs about Rs. 10,000|- which is equivalent to the value of 10 pairs of bullocks these days.

A word of caution is, however, necessary in applying the economics of these calculations *in toto* in case of *kisans* and small holders. In their case major portion of expenditure shown here on bullocks and labour has not to be incurred on account of use of family labour and stock of bullocks in existence but in the case of tractor farming the advantage of family labour would not remain. Cash expenditure would be required for purchase of machines, fuel repairs, and on the skilled staff whereas there will probably be left no alternative scpoe for gainful employment of the farmers. The personnel for skilled work e.g., driving of machines, would not be obtainable from amongst them immediately for lack of education and necessary training. In case of bullock farming, about Rs. 12,000|- of the total expenditure of Rs. 13,000|- are earned by family labour or hired labour residing in the villages but in case of mechanised farming, hardly Rs. 1,000|- would be earned by labour and the rest i.e., Rs. 8,800|- will have to be spent in cash on fuel, pay of skilled workers and maintenance of the machines. Moreover, a larger part of this money will not remain in the country itself but will go out to foreign countries which would be supplying machines, parts and fuel. Before advocating large scale mechanisation, it is necessary, therefore, to understand its full economic implications.

As regards the formidable obstacle of small sized holdings in the way of mechanised agriculture it may be said that with the agrarian reform under consideration in each province it appears that in the near future, the existing distribution of land holdings may be reorganised into more economic units or some sort of joint effort in various operations may be adopted even with the existing individual units of cultivation. In that case machines can be jointly owned and used on custom basis. Even in U.S.A. where average holdings are of the order of 148 acres, about 1.4 million farms or 23% of all farms in 1939 reported no tractor or animal power and used custom or exchange tractors or animals; 3.9 million farms of the 6 million farms were not highly mechanised.

Invention of new machines is widening their scope to operations which hitherto could be performed by hand or manual labour only. The new trend in manufacturing tractors and agricultural machines is to make them more adaptable to small farms and convenient for small pockets. Their efficiency is increasing, resulting in greater economies in operation and saving of money in comparison to manual labour. A few examples of new inventions are given below. A potato harvestor digs, gathers, grades, sacks, weighs and delivers the potato to a waiting truck with an estimated saving of 50 dollars a day or more over the old way of handling the crop. The experimental planter opens the beds, plants the seeds and places the fertilizer all at one time. There is considerable saving in the quantity of fertilizer used and its cost in this method. The cotton picker has been designed to

extract lint-cotton from the open balls. A sugarcane harvestor cuts the cane and loads it at a speed of 7 to 8 miles an hour with an estimated saving of 1|2 to 1|3 of the hand harvest labour. Aeroplanes are being used for dusting and spraying crops against disease and pests. Rice fields to be airplanted are flooded first and seeded at about 50 acres an hour.

In countries with mechanised farming, the development of the general purpose tractor and its complement of tools in 1920s and the extensive use of rubber tyre in the late 1930s helped greatly in advancing the usefulness of tractors and their widespread adoption. Formerly, the farm tractors were used almost exclusively for the heavier farm jobs, as ploughing and discing and belt work. The use of petrol fuel and rubber tyres has made possible the manufacture of light type tractors suitable for garden cultivation and small farms. There are available in the market a number of types of garden tractors varying in horse power from $1\frac{1}{2}$ to 10. The small $1\frac{1}{2}$ H.P. to 2 H.P. walking type tractors weigh only 150 to 250 lbs. Another type i.e. riding tractors are made upon a tricycle wheel arrangement, which makes for extreme manoeuvreability and is an answer to the problem of combining low cost with the labour saving feature of a large tractor.

MECHANISATION AND THE U.P. GOVERNMENT

As regards the views of the provincial government on mechanisation in agriculture the conclusions of the U.P. Zamindari Abolition Committee which worked under the chairmanship of the Hon'ble Premier, are as follows:

"On a consideration of the purely economic aspects of agricultural technique, we are of the opinion that mechanisation of agriculture is not desirable, mainly on the following grounds:—

(1) Mechanised agriculture does not lead to the maximum use of land. Considering that we have got only about 0.7 acre land per head of the population it is necessary to employ the most intensive methods to make this small area yield enough food for the people.

(2) Mechanised agriculture would lead to the displacement of a large proportion of the rural population dependent upon land. Considering that we have got a surplus of labour, the use of machines that would increase the number of persons who are unemployed or under-empolyed is not, in the present circumstances, desirable.

(3) Lack of capital resources and absence of local fuel supply.

Though we have not advocated the general use of large machines to replace human and animal labour, we think there is considerable scope for mechanised agriculture :

(i) On experimental farms, designed to test the productivity of such farms under Indian conditions.

(ii) For the eradication of deep-rooted weeds like *kans*, cleaning land under jungle, anti-erosion works such as contour terracing, bunding and gully-ploughing, and the reclamation of waste land by mechanised means."

Mechanical means of cultivation have been employed for land reclamation in U.P. It is estimated that about 100,000 acres of fresh land would be brought under cultivation, 9,000 families settled on it and nearly 5.5 lakh maunds of grain will be added to the food resources of the province.

Five existing cattle breeding farms and two new farms are being mechanised with a view to experiment in mechanised farming for the guidance of agriculturists. These farms will undertake the training of tractor drivers and mechanics and the sons of cultivators in mechanised farming. Mixed farming will be carried on them. They will be run entirely on commercial lines and will not only serve as centres of demonstration but will produce large stock of pedigree seed, live-stock, milk and milk products. After the farms have been well mechanised and completed a few years' working, very interesting and informative data are likely to be made available on the economics of mechanised farming.

DETAILS OF THE MECHANISED STATE FARMS IN U.P.

No.	Name of the Farm	Area in acres	Live-Stock (Milch & Young cattle)	Estimated capital expenditure in Rs.	Annual Estimated cost in Rs.
1.	Bharari ..	650	304	330,600	295,200
2.	Babugarh ..	750	328	399,200	304,790
3.	Madhuri Kund..	900	536	308,900	459,610
4.	Manjhra ..	300	203	263,300	147,250
5.	Hempur ..	1,800	750	785,700	707,200
6.	Nilgaon ..	400	181	277,500	179,900
7.	Niblett ..	500	226	264,600	221,950

The above estimates are most preliminary.

A detailed scheme has been prepared for *kans* eradication in Jhansi district. It envisages establishment of four tractor units one in each Tehsil with a complement of 60 tractors. The cost of deep ploughing is estimated at Rs. 24|- per acre. One half of the cost of *kans* control is chargeable from cultivators and the other half is treated as subsidy. For the first time in the history of the district, 30 tractors working together have started ploughing on March 7, 1948 with Ranson Super-track ploughs 10,000 acres of *kans* infested areas in Mahroni Tehsil.

Power cultivation is carried out by the departmental tractors, on hire basis, on private land.

The Agricultural Engineering Section has been reorganised and strengthened. Its activities have been classified into 3 services—

(1) Irrigation service,

(2) Tractor service, and

(3) Implements service.

The Province in due course will have four tractor zones with proper staff and well equipped workshops to serve the specialized needs of various types of tractors, their implements and other agricultural machinery, like oil engines, pumps, generating plants, etc. One of these four workshops will serve as a centre for research, design and manufacture of bullock drawn implements and small power pumping plants and implements. An immediate start is being made in imparting training to active and young agriculturists in manufacturing parts of implements and machinery and driving oil engines and agricultural machinery and in their proper upkeep, by opening ten rural workshops. A mechanical bias will, thus, be created in rural areas, and such small workshops, it is hoped, will spring up all over the province.

CONCLUSION

Mechanisation in India has a future ahead though intervened by several difficulties. Our country is in various stages of progress. The cart and the plane, the boat and the ship are all side by side. So will be the case with mechanisation of agriculture. Neither bullocks nor hand labour would be completely eliminated from Indian agriculture in the near future. Probably 99% of the farms of the world are operated by manual labour. Even in U.S.A. the number of horses and mules on farms was more than 10 million heads in 1947; approximately 60% of men hours spent on farms in 1944 were done with the hands or with small hand tools—axe, pitch fork, shovel, hoe, husking peg, pruning knife, etc.

Emphasis may be laid on the need for regulated development of farm mechanisation. The reins should be held tight to secure an organised and systematic development. Great caution and steadiness are needed in the progress of that aspect of mechanisation which is to compete with our labour and bullock force in order to adjust the coming change without any violent disturbance in our agricultural and social economy. The provision of alternative avenues of employment to persons displaced must claim the first attention of the State. Also, there is need for regulating the distribution resulting from mechanisation of agriculture among the existing rural sectors in a manner so as to minimize the hardships of unemployment and ensure more leisure for cultural needs, such as education, recreation, health, hygiene and sanitation.

Experimental stations need to be established to test and try the different agricultural machines of various makes. Individuals should be able to get expert guidance and advice from the State maintained specialist staff in selecting the machines for their requirements. Wastage of funds and permanent damage to the land may be effectively prevented if the intending purchasers have an easy access to expert advice and are not left entirely at the mercy of manufacturing firms for the selection of machines and tillage implements. Experiments should be conducted to see that the use of different types of machinery in cultivation operations does not injure the long term capacity of the soil to produce crops. Temporary stepping up of production at the cost of long term productivity of soil should be discouraged. Lighter cultivation appears more suitable to our soils and climate. Recent experimental evidence in U.K. and U.S.A. is not much in favour of deep cultivation or soil inversion. Such a method of tillage which ruled the art of soil cultivation during the last hundred years is being found not in the best interest of soil conservation or long term maintenance of soil and its fertility. The more recent trend is in favour of stubble mulch farming which consists of stirring the soil a little below the surface and allowing the stubbles and residue of the previous crop undisturbed on the surface. This is very similar to what our much maligned country plough does. It has proved very effective in increasing the moisture holding capacity of soil and cutting losses by erosion. It is also necessary to point out that the association of mechanisation with deep cultivation or soil inversion is not correct. Mechanisation means only use of power; and tillage operations will depend on the type of the implements used. Very efficient light implements for stubble mulch cultivation have been designed in U.S.A. Similarly our agricultural engineers can also evolve a suitable set of implements in close contact with Agronomists and Agro-Economists. The training of operators, skilled wokers, and maintaining of repair workshops and a stock of spare parts may also be the State responsibility in initial stages of development. The farmer also should be trained in the use of plants and implements.

It is only through caution, precaution and experimentation that mechanisation may prove a blessing to Indian agriculturists.

MECHANISATION OF INDIAN AGRICULTURE

by

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Introduction: Adequate supply of food is a matter of paramount national concern. The food position in India is extremely bad and large amounts of money are being spent every year for importing food grains

from foreign countries. If India is to become self-sufficient in matter of food stuffs at a far greater rate of consumption than that at present and in addition be able to export such agricultural products as there is world demand for, then it becomes an obvious necessity to increase the efficiency of Indian agriculture by every possible means. Increasing the efficiency of Indian agriculture involves four fundamental and essential features, first adequate quantity of production, second satisfactory quality of products, third production at a low cost and fourth the well being of those that are engaged in the occupation. A cursory survey of the present conditions in India, indicates that the quantity to production is far from being adequate, the quality unsatisfactory, the cost of production excessive and the general well being of those that are engaged in agriculture is very poor and far behind the favourable standard of living enjoyed by those in other vocations. Thus the present need in the country is to increase the standard of production, make the country self-sufficient in matter of food-grains and improve the living conditions of agricultural population. Countries like U.S.A., Canada, Australia and Russia have derived immense benefits by the increased application of machinery and motive power in agricultural operations. The subject of power farming in India has received some attention in the past and it has resulted in various attempts to introduce power driven agricultural equipment. But little success attended these efforts due to the failure of the imported equipment to give satisfactory results under Indian conditions. The interest in mechanization has once more become prominent and serious efforts are now being made to replace the primitive methods of agriculture by modern methods. In what directions the machinery can be economically employed, whether or not the conditions in India are conducive for large scale power farming and whether the social and financial conditions of the country are suitable for the introduction of mechanization are some of the problems which require thorough investigation.

II. Power requirements of the Farm

Power is required on the farm for performing two kinds of jobs.

First, tractive work requiring pulling or drawing effort, such as ploughing and land preparation, seeding inter-culture, harvesting, etc., and also hauling.

Second stationary work such as water lifting, threshing, sugar cane crushing, and other jobs of like nature.

The available sources of power on the farm are domestic animals, heat engines and electric power. While electric power, which at present is available only in a very limited extent, is confined entirely to stationary work, animal power and heat engines have proved applicable for both tractive and stationary works. In India, the power required for carrying out

agricultural operations is mostly supplied by animal power and human hands.

The animal power is a very flexible prime mover being adaptable in practically all types of draught work. It has a great reserve power for emergencies and for temporary heavy over loads. It uses the feed that is produced largely on the field. It can be used fairly well in wet or lose grounds, but the disadvantages are that it requires feed and care when not working, requires frequent resting periods, its working speed is low, it is not efficient for stationary work, and requires the products from one-fourth of the crop land to feed them. On the other hand, mechanical power in the form of a diesel engine has the following advantages in doing the farm work. It can work continuously at heavy loads, needs little attention when not in use, and is adaptable to draft belt and power take of work. But it requires cash expenditure for fuel and lubricants and also requires considerable mechanical skill for successful operation. Thus, it will be seen that both animal and mechanical power have their individual advantages and disadvantages. It will never be possible to completely replace the animal power by mechanical power. Even in a highly mechanized country like America, 40 per cent of the power needed on the farm is still being furnished by animals, while tractors supply about 35 per cent and steam engines, gas engines, wind mills, electric plants and trucks supply the remaining power. Bullocks are likely to remain the chief motive power of Indian Agriculture for a long time to come but mechanical power could undoubtedly be used to advantage in certain agricultural operations.

III. Scope for Mechanization

Though the immediate desire should be to improve existing implements under bullock power rather than to attempt to simplify complex implements which have been designed primarily for mechanical power under western conditions of agriculture, efforts should also be made to utilize mechanical power in such jobs where it is eminently suited, from the point of efficiency and economy. The immediate need in the country is to increase the productivity of the land and this can be achieved firstly by increasing the yield per acre in lands which are already under cultivation and secondly by bringing more area under the plough. Mechanical power is suitable for the following operations:—

(a) Extending the area under cultivation by eradication of deep rooted weeds, by primary land reclamation and by contour bund construction for prevention of soil erosion.

(b) Light and shallow cultivation on large estates when a considerable area has to be cultivated in the shortest possible time.

(c) Development of ground water resources.

Weed eradication: Deep rooted weeds present almost insuperable obstacles to hand labour and animal drawn implements. The presence of weeds decreases the yield considerably by robbing the plants of their plant food. Vast tracts of India are covered with deep rooted weeds which cannot be effectively eradicated by the cultivator with his bullocks and country plough. Lack of equipment for effective eradication of these deep rooted weeds has resulted in the abandonment of considerable areas of once cultivated land. The roots of commonly found weeds like *kans* and *hariyali* go to 10" to 12" depth. If the soil is turned over during the dry season to a depth somewhat greater than that of the root mat, the soil clods completely dry out in a few days, and the roots dry out for lack of moisture. The only economical way of doing this is by deep ploughing with a high powered tractor equipped with suitable implements.

Land Reclamation: The net cultivated area per head in India amounts to 0.7 acre as against 2 to 2.5 acres in America and Europe. The standard of living of people in India is low but it is wrong to assume that the present per capita acreage is sufficient in the country. At least one acre per capita is indispensable for the sustenance of the population. On this basis at least 120 million acres more should be added to the area under cultivation. The population is increasing at the rate of 5 millions per year. To meet the requirements of increased population, 5 million acres of land should be added every year to the cultivated area under the present standard of farming or farming technique should be revolutionized and production intensified. Since 1901, the population has increased by about 35 per cent while the cultivated area has registered an increase of only 5 per cent. This has certainly lowered the standard of living in the country and reduced the people to the verge of starvation.

Thousands of acres of land remain abandoned due to hillocks, depressions and gullies, scrub trees and shrubs. About 3 million acres of cultivable waste land is available in Hyderabad. The total land classified as cultivable waste throughout India amounts to 170 million acres. A substantial portion of this area can be made fit for cultivation by suitable operations, which are beyond the scope of an average cultivator who depends on his bullock power. With tractor operated equipment, it will be possible to uproot the smaller shrubs, level the ground and fill the gullies at reasonable cost and in the shortest possible time.

Prevention of Soil Erosion: The prevention of soil erosion is now being recognised as one of the most important problems in agriculture. Soil erosion is the process of wearing away of fertile top-soil of the land due to wind and water. When there is intense rain, the beating rain drops dig out the soil particles which are carried away by the rushing water. The top-soil which is so essential for plant growth is washed away and what

is left is simply a mass of moulds and gullies. The losses in plant nutrients due to erosion have been estimated to be several times greater than the removal of plant food from the soil by the chop. Erosion not only causes loss of soil but also decreases the fertility of the land. Plant foods in the form of chemicals are dissolved in water and are carried away with the flow of water. The loss of humus reduces the absorptive capacity of the soil. For countless decades the forces of erosion have gone unchecked. The beginning of soil erosion starts with peeling off of surface layers of soil which gradually leads to even broadening and deepening gullies. The problem is twofold: first, to restrict the enormous wearing of surface soil and secondly to make the maximum use of available rain for cultivation. The factors that greatly influence erosion are intensity of rainfall, slope of the land and the nature of the soil. Contour bunding has proved to be the most effective method for conservation of soil and water. The slopes are graded with horizontal terraces which will vary in size according to the steepness of the slopes. Bunding and terracing on large scale can be carried out more economically by self propelled graders and terracers than by manual labour.

Preparation of Land: A major portion of crop production in India is solely dependent on the monsoon rains. The cultivator in many ways is unprepared to utilize fully the water of the monsoons. A substantial quantity of monsoon water runs off the agricultural lands. During the months of dry season, the soil gradually loses all its moisture and gets harder and harder up to 8 to 12 inches. The country plough cannot penetrate into the soil and it is very expensive to employ hand digging on such an extensive area. Thus the cultivator has to wait until the rains have fallen to moisten the top few inches before he commences his ploughing operations. Before he is ready to plant, a lot of the monsoon passes away and his crop will then have to depend on the remaining part of the rainy season. In many tracts, the rain-fall is quite uncertain and often badly distributed as regards crop requirements throughout the year. Crops fail often due to the vagaries of rainfall. It is thus essential that the monsoon should be harnessed fully and every drop of water should be saved and retained in the soil. This is possible only when the hardened soil is ploughed deep before the first down-pour of the monsoons so that the entire rain water may soak into the soil. This will help the cultivator to begin his planting with the first downpour. With deep ploughing, the agricultural land will be able to hold a great quantity of water and the yield of crop will be far more abundant than what it would be if the land is ploughed with *desi* plough.

Development of ground water resources: Water is indispensable to cultivation and is more valuable than land because when water is applied to land, it increases its productivity at least six fold and renders great

extents of land productive which otherwise produce nothing. India already possesses the largest cannal irrigation system in the world and many new irrigation projects, already taken in hand, will bring into use millions of acres of new land suitable for cultivation. Apart from cannal irrigation, irrigation by wells is to be found everywhere in the country. Out of the total area under irrigation, 35 per cent is still under well irrigation. The well irrigation system, at present suffers from two handicaps. Firstly, the quantity of water obtainable from wells is uncertain and secondly, the only power available for lifting water from the wells is that of bullocks which is most unsuitable for pumping purposes.

Abundant quantity of water is available as ground water which has not been fully utilized so far. Its importance will be fully appreciated if it is considered that the quantity of water within the part of the earths' crust relatively close to the surface, is believed to be equal to one-third of the total volume of water in the sea. It is generally admitted that the water exists almost invariably under all parts of earth's surface, although it may sometimes be located at such depths as to be of no possible use to man. The vast reservoir of ground water, if fully developed, can supply abundant quantity of water to extensive areas which at present lie comparatively waste wanting only water to convert them into plains of richest cultivation. Mechanical power could be used advantageously for the development of ground water resources which involves the sinking of bore holes which constitute the principal sources of obtaining a dependable supply of water from under ground sources and also operating efficient pumping appliances for lifting water from these bore holes as well as from shallow wells.

From the above, it will be seen that for land development and for annual ploughing on large estates, the tractor is most suitable while stationary oil engines can be utilized for sinking bore holes and for water lifting.

IV. Factors Affecting Mechanisation

Adoption of power equipment for agricultural operations is desirable only if the net earnings of its owner are increased through its use. The factors that affect the success of mechanization are:—

(a) Economic condition of the cultivators.

(b) Relative cost of work.

(c) Operating and servicing facilities.

Economic Condition: Out of the many important factors that have to be considered in the agricultural development of India, the consideration of the Indian ryot's economic life is the most important. India is largely a

country of small scale farming and the holdings have been greatly reduced in successive sub-divisions. The average holdings in the country range from 5 to 15 acres. Sub-division of holdings has been a continuous process so that the size is being reduced every year. Increased pressure of population, dissolution of joint family system caused by the spirit of individualism and prevailing social customs and laws of inheritance have been responsible for fragmentation of holdings. Plots comprising of a holding instead of being in one compact block are scattered and separated by plots of others. The vast number of small land holders have very limited means and often exist in abject poverty. These small land-holders are a source of serious handicap for the introduction of modern equipment. A large number of small holdings are too small to support the cultivator and his family without some subsidiary source of income. The adoption of improved methods of cultivation, machinery and labour-saving devices is entirely out of question for the average Indian cultivator, on account of his very small scale of operations and the limited resources at his command.

If, however, the small land holders are not considered there are still a good number of large land holders who can afford to purchase machinery for farm work. If large land holders use modern equipment for farm work, their less fortunate neighbours will observe the results and perhaps acquire the desire, if not the ability, to procure modern equipment and this process of education will be a very important step in the modernization of Indian agriculture.

Cost of Work: The factor that decides whether or not mechanization proves successful is the relative cost of work. There is nothing in the way of agricultural operation on the land which cannot be done by hand labour, though not always by animal labour. If manual and animal labour is cheap and is available in plenty, there is nothing which induces a cultivator to go in for machinery. The standard of living of farm labour has been very low in India in the past and agricultural labour used to be available freely at cheap rates before the recent world war. Due to scarcity of essential commodities, the cost of living has increased enormously. The labourer has now become conscious of his poor standard of living and feels the necessity for better food, better clothing and better shelter. The country has been undergoing a certain degree of industrial development with the result that there has been a movement of labour from farm to factory. This migration has taken away the backbone of village life and has brought about a shortage of labour for farm work. Large land holders are finding great difficulty in obtaining cheap farm labour and this inevitably creates an urge for mechanization. There is one more reason for the gradual drift of labour from agriculture to industry. The period of agricultural activity is limited. Twice or thrice a year, there is intense activity on the land for

a limited period and at all other times, the volume of work to be done is comparatively negligible. The labourer often is unable to find sufficient work with which he can keep himself busy all the year round. Thus he prefers to migrate from village to city. There is also a country-wide shortage of draught animals. Agricultural operations under the present circumstances have become very costly.

. *Operating and Servicing Facilities:* The cultivator's unfamiliarity with the machinery and his complete lack of technical knowledge are serious draw backs to the use of modern implements. If machinery is not properly handled, breakdown will be frequent. It often happens that when a new implement is introduced, it may be so handled by untrained worker that although under ordinary conditions it would be satisfactory and efficient, it comes to be considered as unsuitable for the work. Without proper training it would be futile to entrust costly machinery in the hands of farm labourers. Generally, the cultivator, though he has funds for the purchase of farm machinery, is reluctant to go in for machinery for fear of the machine lying idle due to lack of an operator. During the wartime many unskilled labourers were trained as mechanics, fitters, tank drivers and lorry drivers, who after demobilization could have proved very useful for handling farm machinery. But unfortunately, the war-returned technicians are being looked upon as undependable and reckless in handling machinery.

The other difficulty commonly experienced in using machinery is lack of servicing and repair facilities. Machinery requires intelligent care and should be kept in good repair if it is to render efficient service. It is not uncommon that costly machinery remains discarded after a few days of service because of small breakages, which could not be put right for want of repair facilities. If workshop facilities for repairing and general overhauling are not assured to the cultivator, popularizing modern equipment for farm work will not be successful. Dealers of machinery will not pay any attention to the customer once he disposes of the machine. The dealers would find it too expensive to open servicing stations for the benefit of their customers because of the limited size of the market. Even spare parts cannot be supplied by these dealers in time, with the result that the users of farm machinery get highly disappointed and feel sorry for having invested considerable amount for the purchase of machinery.

V. Agency for Carrying out the work

In India small holdings predominate making tractor ploughing by an individual in many cases impossible even though he may wish to have his lands tractor ploughed and he may wish to reap the advantages of modern methods of cultivation. Without consolidation of fragmented holdings either by co-operative effort or by compulsion by the Government, it is not

possible for individuals having small holdings to purchase and work tractors. The possibilities of carrying tractor work are:—

(a) by State effort,

(b) by effort of individuals having large holdings,

(c) by Co-operative effort, and

(d) by Contract methods.

State Effort: Ordinary cultivators without external aid cannot undertake large scale reclamation or bunding work. In implementing Post-War Agricultural Plans some of the Provincial and State Governments have obtained a small number of high powered tractors for extending the area under cultivation. Land reclamation, clearing lands infested with deep rooted weeds and contour bunding for prevention of soil erosion with help of tractors and tractor drawn implements should be managed and executed by the staff employed by the Government. Subsidies to the extent of 50 per cent and taccavi loans for the remaining amounts recoverable in easy annual instalments should be issued to the cultivators, if mechanization should prove successful. The aim should be to bring in each year at least 5 million additional acres under cultivation. On the basis of 1,000 acres per tractor per year, at least 5,000 tractors of 70 to 100 H.P. with necessary equipment are essential for this purpose. When we consider the number of tractors operating in agriculturally advanced countries, the figure of 5,000 tractors seems insignificant. The number of tractors operating in British farms is estimated to be in the neighbourhood of 1,50,000. In United States, there are today 2 million tractors operating. In Russia where mechanization has progressed systematically, there were 27,000 tractors in 1928 and the figure rose to 5 lakhs by 1940. However, in new countries, shortage of labour and almost unlimited amount of land at an early stage of development provided an incentive for large scale mechanization. Without substantial state aid, mechanization cannot make any headway in India.

Individual Effort: The number of cultivators owning more than 100 acres is hardly one per cent of the total number of owners. An area of at least 200 acres is considered necessary for owning a tractor provided all operations are mechanized. The total number of cultivators who could afford to purchase and work tractors would be about one lakh. If these large land holders are properly advised and made to understand the various advantages of power farming, it would help a great deal in popularising mechanization.

Co-operative Effort: If co-operative societies for means of production are formed, mechanical cultivation can be more easily adopted than what it would be under present circumstances. Co-operative farming implies mutual assistance and pooling of individual resources for the benefit of all. Land and other means of production will remain the property of the individual farmer.

Each society will have its own tractor which will plough the land of each member with the result that the land now remaining uncultivated will be brought under cultivation, the crop yields will improve and the number of bullocks required will be reduced. Mechanization will prove economical if the machinery is employed fully for at least nine months in the year in various agricultural operations such as ploughing, harrowing, sowing, etc. and other stationary purposes like pumping, sugarcane crushing, chaff cuting etc. There is no difficulty for the big landlord to do this but for the small land holder it is not possible unless he groups himself with other small land holders. It is desirable that the Government in their new Resettlement plans adopt colonization on a co-operative basis.

Contract Work: Farming requires systematic planning and organization in the same way as an industrial production. If agricultural development is undertaken by Public Utility Companies and mechanical cultivation on contract basis is adopted by these commercial concerns, the average cultivator gets the benefit of expert centralised supervision and all the advantages of mechanized cultivation without incurring heavy expenditure in purchasing costly machinery. There is a very large demand for tractor work on contract basis and thousands of acres can be obtained at profitable rates. Joint Stock Companies should be formed for this purpose and they should carry out preliminary surveys in selected areas. With centralised organization and adequate facilities for servicing and repairing of tractors, the companies will be able to carry out mechanization of agriculture at a far greater speed than what is possible by any other agency and they will thus be benefitting the huge agricultural population as well as their share-holders. The Government should encourage and give all facilities for promoting such Companies.

VI. Economics of Mechanization

The items that have to be taken into account for examining the economic aspect of mechanization are:—

1. Interest and depreciation.
2. Running expenses.
3. Cost of repair and service.
4. Labour and supervision charges.
5. Miscellaneous charges as transport etc.

As it has already been stated that mechanization should be adopted only for certain agricultural operations, the comparison of costs will be limited to the following items:—

(a) Tractor and bullock or manual power for land development and also for annual ploughing on large estates.

(b) Well irrigation by tube wells fitted with power pumps and open dug wells fitted with bullock drawn *mhotes.*

Tractor power versus bullock or manual labour

The useful life of a tractor under field conditions may be taken at 10,000 hours or 5 years with 2,000 hours of working per year. On this basis the rate of depreciation will be 20 per cent. The interest on capital outlay may be taken at 4 per cent. Considering a 100 H.P. tractor attached with necessary ploughing equipment the cost of work per hour will be as follows. The cost of the tractor with plough outfit would be about Rs. 35,000.

	Rs.	As.	Ps.	Rs.	As.	Ps.
1. Interest and depreciation per hour at 4 per cent and 20 per cent per year of 2,000 hours respectively on Rs. 35,000				4	3	3
2. Running expenses per hour: 5 gallons of H. S. Disel Oil at Rs. 1-8-0 per gallon	7	8	0			
1 gallon of lubrication	3	8	0			
Grease 2 Lbs.	2	0	0			
Cotton waste	0	8	0			
				13	8	0
3. Cost of repair and service per hour				2	0	0
4. Labour and supervision charges per hour: Driver	0	8	0			
Cleaner	0	2	0			
Supervisory and service staff	0	8	0			
				1	2	0
5. Miscellaneous expenses per hour				1	0	0
Total cost per hour				21	13	3

A tractor of this type can plough 3|4 of an acre in one hour in hard clay soils to a depth of 12" to 14". The cost per acre works out to be Rs. 29-1-8 or say Rs. 29. The cost per horse-power hour works out to be Rs. 0-3-6. If the same work has to be done by digging by manual power the cost will be as follows:

Total excavation in one acre to a depth of one foot will be 43,560 cubic feet and the cost of excavation at Rs. 0-8-0 per 100 cu. ft. will be Rs. 217-8-0 as against Rs. 29 by tractor.

An average person's working capacity is expected to equal 1|10th horse-power. At Rs. 1-4-0 wages for one day of 8 hours, working the cost of horse-power by manual labour works out to Rs. 1-9-0 as against Rs. 0-3-6 by tractor. Thus it will be seen that work by tractor will cost only 1|7th of what it will cost if the work is done by manual labour. It may be noted that bullock

power is of no use for deep ploughing in black cotton soils infested with weeds, where hand digging or tractor ploughing is the only solution. Similarly in developed areas the cost of ploughing by tractors can be compared with that by bullock power. A pair of bullocks is expected to develop one horse-power. For shallow ploughing in medium soils, 40 H.P. tractor is considered suitable. To do the same job as a tractor of 40 H.P., 40 pairs of bullocks are required. In appendix I, details of cost comparison are given from which it will be seen that for ploughing 6" to 8" in medium soils, it will cost Rs. 7-8-0 per acre by tractor and Rs. 11 per acre by bullock power. Thus farm work is definitely cheaper by tractor than by manual or bullock power.

The tractors can be utilised actively for a period of 8 months from November to June. During the period when ploughing is not possible, the tractors could be utilized for stationary purposes. The tractors are extremely adoptable power units and power may be delivered at drawbar, at a belt pulley or at the special power take off. As a stationary engine, it can be utilized for pumping, crushing and such other jobs.

Well irrigation by tube well and open dug well

The choice of open well and the bore well sites depends upon topography, geological conditions of the underlying rocks and other features like rainfall, climate etc. The supply obtainable from a percolation well is rarely sufficient to the agriculturist, unless the well is sunk in a large area and to a great depth. The dimension of an open dug well will vary according to the water bearing stratum and the rate of consumption. On an average an open dug well of 20 feet by 20 feet taken to a depth of 50 feet is taken for consideration in Hyderabad. A well of this size is expected to yield water sufficient for irrigating paddy lands of 8 acres in *abi* season and 4 acres in *tabi* season, or a total of 12 acres in one year. An average pair of bullocks, working a *deshi mhote* is expected to deliver 500 gallons of water per hour. With 3 such *mhotes* working for 6 hours and for 8 months in an year for both the seasons, it will be possible to irrigate 12 acres of land. In case where the ground water is deep below the surface beyond 80 feet, the open method of sinking is too difficult to adopt. All rocks, whether igneous or sedimentary, however massive or solid, are traversed by fissures or joints, which are liable to be opened out by the mechanical and chemical action of ground water or by movements of earth's crust. Water in these under-ground strata being generally under pressure, a much smaller size of well suffices to ensure a constant supply, because the lower water-bearing stratum constitutes a natural reservoir. Thus a tube well of 6" to 10" diameter taken to a depth of 100' in a favourable water bearing stratum,

is expected to supply abundant quantity of water for irrigation atleast 14 acres of land in *abi* and 7 acres in *tabi* season or 21 acres in one year.

On the above basis, comparison of cost of irrigating by tube well and open dug well is worked out and is shown in appendix II. From this it will be seen that it costs Rs. 170 for irrigating one acre by a tube well and Rs. 243 by open dug well. It is also seen that the net income on one acre of land is Rs. 150 by tube well irrigation, while the income by open dug well irrigation is only Rs. 127. In alluvial soils and river beds, copius supply of water can be assured and each tube well of 10" diameter can easily command atleast 40 acres of land in which case the income by tube well be very considerable. If cheap electrical power is available in rural areas, which will be possible only when the major Hydro-electrical schemes come into operation, the cost of pumping with the help of an electrical motor will be very cheap and the net income per acre can be expected to be not less than Rs. 200.

Conclusion

From the above discussions, it is seen that mechanization has immense advantages of time and labour savings and offers a solution for tiding over the present food crisis in the country. It may be summarised that:—

1. Under the existing social and economic conditions of Indian ryots, whole sale mechanization of Indian agriculture is neither possible nor desirable.
2. Mechanization could be adopted to certain agricultural operations with advantage. It is a question of machine power supplementing the bullock power and not replacing it.
3. Without substantial Government aid, mechanization can not make any head way in India.

In view of the above conclusions, the Government of Hyderabad should plan out mechanization of agriculture keeping the following suggestions in view :—

1. There shall be atleast one High powered tractor in each taluqa or about 150 tractors in all throughout the State. The present scheme of 25 to 30 tractors should be increased to that of 150. These tractors should be operated by Government Technicians and be utilised for land development and for annual ploughing in cultivator's lands on hired system. Subsidies to the extent of 50 per cent and the taccavi for the remaining amount should be granted for primary land reclamation works.
2. There shall be one mobile repair unit containing machinery for field repairs, attached to each district headquarters. There shall be one second line repair work shop situated at the headquarters of each

Suba. There shall be one principal agricultural repairing work-shop under the Department of Agriculture and situated in Hyderabad.

3. Rich landlords owning more than 200 acres of land should be encouraged to purchase tractors for their agricultural operations. Facilities must be provided for servicing and repair of tractors and tractor drawn implements in use by individual cultivators in Government Agricultural work-shops.

4. If sufficient acreage belonging to one cultivator is available at one spot, and underground strata is favourable, irrigating with tube well should be preferred and the Government should construct such wells complete with pumping appliance and hand over them to the cultivators. The cost of the well should be recovered in easy instalments after allowing atleast 25 per cent as subsidy.

APPENDIX No. I

COMPARISON OF COSTS BY TRACTORS AND BULLOCK POWER

S. No.	Particulars	Ploughing by a 40 H. P. tractor with a Mould Board Plough		Ploughing with 40 Pairs of Bullocks equivalent to 40 H.P.	
			Rs.		Rs.
1.	Capital outlay ..	Tractor and implements ..	25,000/-	at 400 each bullock	32,000/-
2.	Depreciation Per year	5 years' life	5,000/-	10 years' life	3,200/-
3.	Interest	.. 4%	1,000/-	4%	1,280
4.	Running expenses ..	Cost per hour :—			
		2 gallons fuel oil .. 3 0 0			
		½ gallon lubrication 1 12 0			
		1 lb. grease 1 0 0			
		Cotton waste 0 8 0		Fodder @ 40/- per month per pair of bullocks and per year	
		Cost per hour 6 4 0		for 40 pairs	19,200/-
		Per year of 2,000 hours of working	12,500/-		
5.	Repair	@ Re. 1/- per hour & for 2,000 hours of working in a year ..	2,000/-	@ Rs. 10/- per set of implements and for 40 sets ..	400/-
6.	Labour charges ..	Driver @ Rs. 90/- per month & cleaner at Rs. 30/- per month for 1 year	1,440/-	30 men for 8 months & 10 men for 12 months at Rs. 25/- per month.	9,000/-
	Total operating costs per year including interest & depreciation running expenses, repair & labour charges	.. ..	21,940/-	.. ..	33,000/-
	Total anticipated output of work	at 1½ acres per hour & for 2,000 hours of working in a year	3,000/-acres		3,000. acres
	Cost per acre	Rs. 7.31 or say Rs. 7-8/- per acre		Rs. 11.03 or say Rs. 11-0-0 per acre	
	Cost per horse-power hour	Rs. 0-4-6		Rs. 0-6-8	

APPENDIX No. II

COMPARISON OF COSTS OF IRRIGATION BY TUBE WELL AND OPEN DUG WELL

S. No.	Particulars	Irrigation by tube well fitted with power pump		Irrigation by open dug well fitted with bullock mhotes	
			Rs.		Rs.
1.	CAPITAL OUTLAY				
	(*a*) Well construction	100′ boring	1,500 0 0	Excavation up to 50′	2,000/-
		40′ strainers	.. 600 0 0	Stone Masonary..	
		60′ casing	.. 900 0 0	Steining upto 25′ ..	2,640/-
		Total	..3000 0 0	Total ..	4,640/-
2.					
	(*b*) Water lifting appliance	Deep well	....	3 pair of second rate bullocks	
		Turbine pump	.. 9,000/-	@ 600/- a pair	1,800/-
		Pipe and fitting	.. 1,000/-	Mhote arrangement Buckets,	
				Ropes etc.	300/-
		Total	.. 10,000/-	Total ..	2,100/-
	RECURRING EXPENDITURE :				
	(*a*) Depreciation only on lifting appliance ..	10 years' life	1,000/-	10 years	210/-
	(*b*) Interest on well & lifting appliance ..	4%	520/-	4%	270/-
	(*c*) Running expenses :				
		2½ galls. fuel oil per day ..	3 12 0	Fodder at Rs. 40/- per pair per	
		Lubricants per day	1 0 0	month & for 12 months & for	
		Cotton waste	0 4 0	3 pairs	1,440/-
		Per day	5 0 0		
		For 240 days	1,200/-		

APPENDIX No. II—*Contd.*

S. No.	Particulars	Irrigation by tube well fitted with power pump		Irrigation by open dug well fitted with bullock mhotes	
	(*d*) Repair	0-8-0 per day	120/-	Repair to well & mhote buckets	100/-
	(*e*) Labour	Driver at Rs. 60/- per month, for 12 months	720/-	3 men at Rs. 25/- per month, for 12 months	900/-
		Total ..	3,560/-		2,920/-
	Anticipated output		21 acres irrigated		12 acres irrigated
	Cost of irrigation per acre		170/-	..	243/-
	Other expenditure for production, manure, seed, tillage operations, harvesting, winnowing etc.		90/-	.. .. ..	90/-
		Total ..	260/-	Total ..	333/-
	Anticipated income 10 pallas at 35/-		350/-	.. ..	350/-
	Hay 15 pallas at 4/-		60/-	.. ..	60/-
	Credit for other works		Nil	Credit for haulage ..	50/-
	Gross income		410/-	.. ..	460/-
	Net income		150/-	.. ..	127/-

MECHANISATION OF AGRICULTURE IN INDIA—ITS ECONOMICS

By

J. P. BHATTACHARJEE

Visva-Bharati.

Machinery and mechanical contrivances came into use in agriculture and farming perhaps in the second quarter of the nineteenth century and the process of their general application in agricultural operations has gone on unchecked ever since. The more highly industrialised countries of Western Europe like England were pioneers in this respect. But since the World War I, leadership of the World in this matter has, thanks to the use of power, passed on to America. The United States and Canada, followed perhaps by Russia and Australia have mechanised their agriculture more than other countries. The internal combustion engine has profoundly affected agricultural production and farm life in these countries. In other words, mechanisation has revolutionised agriculture and the agricultural economy.

Mechanisation of agriculture and farming processes connotes application of machine power to work on land usually performed by bullocks, horses and other draught animals or by human labour. It can be broadly classified into two groups: firstly, mechanisation of work traditionally done by horses and oxen and secondly, of work done by human effort i.e., hand work. By its definition, therefore, mechanisation of agriculture implies replacement of human and animal labour by machine power, in other words, displacement of labour by capital. This necessarily means a change in the economic (organisational) and cost structure of farms, in as much as the ratio of capital to labour increases enormously and the proportion of different items of cost per unit of production undergoes a revolutionary change. In short, mechanisation results in a lowering of the cost of production and affects agriculture in two ways, firstly by increasing the output per head of worker and thus reducing costs of production proportionately and secondly by economising labour and thus throwing a large section of the farm population off the land. It is also held by a school of agricultural engineers that mechanisation increases the over-all productivity of agriculture. This is however a controversial matter. Anyway, what is clear is the fact that mechanisation tends to alter the pattern of agriculture. And this in its turn has very wide and far reaching effects upon the rural and the political economy and sociology of a country. It is against this background of social and economic consequences that the subject of mechanisation of agriculture in India has to be viewed. It is obvious therefore that agricultural mechanisation is not

merely a proposition of agricultural engineering. Internal technical questions apart, it is, perhaps mainly, a problem in agricultural economics. It raises issues like capacity for capital investment on farms, technological possibilities of application of machine power to agricultural operations, its repercussions on agriculture itself and finally its effects both short and long term upon the economy and sociology of the country. The economics of mechanisation of agriculture in India can therefore be discussed briefly under two main heads viz., (1) Conditions and Pre-requisites and (2) Economic consequences. Each of these main heads can in its turn be divided into different sub-heads. Thus conditions and pre-requisites can be considered from (a) technological and (b) economic aspects, while economic consequences can be classified under the categories of (a) wages and costs (b) output and price-level (c) supply of labour, (d) employment (e) farming and (f) economic structure. Let us then turn to these problems.

Conditions and Pre-requisites

The first and perhaps the main point in mechanisation of agriculture is investment of capital. The source of work will be power and not man or animal. Power means machine-tractors, caterpillars with all their accessories like ploughs, disc harrows, drills, cultivators and combine harvestors and these have got to be purchased. Where is the money to come from and how? But before this question is tackled, another problem comes in. Do the objective conditions justify the use of power in agriculture? In other words, are the conditions in agriculture favourable to mechanisation?

Technological conditions: Mechanisation means the application of more power to the agricultural implements than a man or a pair of animals can possess. Naturally it increases the rapidity of work the speed with which farming operations can be performed. According to D R. Bomford, Chairman, Tractor Users' Association of Great Britain, "the ploughman with his three horse team controlled three horse-powers. When given a medium sized crawler tractor he controlled between twenty and thirty horse-powers. His output therefore went up in the ratio of about eight to one."* In India the farmer with his average pair of bullocks, the animal most commonly used for draught purposes in agriculture, does not control more than 1.5 horse-powers. If therefore he uses a medium-sized crawler tractor like the one suggested by Bomford, his output would go up in the ratio of about sixteen to one and he would be able to do in an hour the amount of work he used to do in two working days. This means that the farmer would be able on an average to manage, with the help of such a tractor, a farm in size about 16 times the area that he formerly used to cultivate with the help of

* Article on "Machinery in Modern Farming" by D. R. Bomford in *Farming and Mechanised Agriculture, 1944--45* Ed.—L. F. Easterbrook, P. 56.

one average pair of bullocks. From the point of view of efficiency and output this would no doubt be a very good achievement. But is he in a position to have such a big farm?

It has been estimated that a pair of bullocks on an average can cultivate 6.33 acres of crops in a year in West Bengal.* The use of a medium-sized tractor in place of the pair of bullocks would therefore enable the cultivation of 101.28 acres, or roughly 100 acres of crops in a year. These figures it may be mentioned hold true as much in the case of West Bengal as for the rest of India. It can therefore be said that the replacement of bullocks by medium-sized tractors in India would require for efficient and economic cultivation farms with an average cropped area of about 100 acres. It can of course be argued that if lighter tractors are used the size of farms required would be much less. But the light tractors have certain disadvantages in that they are not usually of the multi-purpose type, suitable for a wide range of operations. However even calculating on the basis of a light tractor with a horse-power between nine and fifteen, the average size of farms required for its economic use would be about 50 acres. How do these figures compare with the size of agricultural holdings in India?

It is a well known fact that India is a land of small peasant farms which are run on the principle of subsistence farming. The holdings are small, sub divided and, what is worse, fragmented into tiny parcels of land. It is also a fact widely recognised that these little bits of land are most unsuitable for the operation of tractors. Whatever the size of holdings, therefore, so long as these are scattered, sub-divided and fragmented there is little scope for the use of power-driven machinery. In other words, even if the size of farms is such as to justify the use of tractors and machinery, the very fact of its being composed of very small plots of land will technically go to hamper the economic and physical use of the machine. Sub-division and fragmentation of holdings in India, operate, both as a fact and as a tendency, against mechanisation of agriculture. Consolidation of holdings will of course remove these difficulties to some extent but this will not be able to do away with the technical necessity of small plots in certain areas and for certain crops. For example, paddy cultivation will be impossible on very big plots of land simply for the reason that unless there are small plots bounded on all sides, water will not accumulate uniformly. The size of such plots will be very small indeed even on slightly sloping lands. There are thus limits to the enlargement of plot sizes.

It is difficult to get accurate, reliable and up-to-date figures for the size and distribution of agricultural holdings in India. The figures given by the Royal Commission on Agriculture are now too old and out of date. The Famine Enquiry (Woodhead) Commission (1945) describes the position

* "Cost of Production and Size of Farms in West Bengal" by J. P. Bhattacharjee *Visva-Bharati Economic Research Publication No. 4*, P. 10.

very truly and correctly in the remark that 'Statistical information about holdings is incomplete and that practically no information is available about farms.'* An idea about the present position can however be obtained from the results of enquiries conducted in some of the Provinces of India in the recent past. The Famine Enquiry Commission mentions some of these investigations and summarises the position from their results. The following table is prepared on the basis of these figures.

Average Size of Holdings in India†

Name of Province	Year of Enquiry	Average size of Holdings in Acres	Yield of cereals per acre of net area sown
			Tons
Bengal	1938-39	4·4	0·48
U.P.	.....	6·0	0·35
Madras	1936-37	4·5	0·41
Punjab	1939	10 (Approx.)	0·34
Bombay	1936-37	11·7	0·19

It is apparent from the above table that the average size of holdings in India is of the order of one-tenth of the average area technically suitable for the use of light tractors. The very small size of holdings in India is therefore a factor going against mechanisation of individual farms at least for the reason that individual farms will not be able to sufficiently utilise and exploit the full powers of tractors and other machines. It may be worthwhile here to compare the average size of holdings in India with the corresponding figures for England and the U.S.A., the two countries which have mechanised their agriculture to a very large extent.

	U.S.A. (1)	England & Wales (2)
No. of holdings or farms (all types) ..	6,096,799	290,600
Average size	174 acres	83 acres
Average area of Mixed Arable farms ..	....	104 acres
Year to which the figures relate	1940	1946

1 Estimated from the Agricultural Statistics, 1945, Published by the U-S. Department of Agriculture. The average size of Mixed and Arable farms in the U.S.A. will be much larger in the Great Plains. Such figures, however, do not give a true picture of the situation, for a good percentage of lands in the U.S.A. have been deprived of their fertility due to soil erosion and become unsuitable for farming.

2 Source : National Farm Survey of England & Wales, 1946.

* *Final Report of the Famine Enquiry (Woodhead) Commission, 1945*, P. 254.

† Ibid· compiled from the pages 254-258.

It appears from above that the objective conditions of land are not favourable to mechanisation of agriculture in India. First of all the individual holdings and farms are too fragmented and parcelled to allow room for the use of mechanical power and secondly they are too small in size to keep tractors and other machines fully and profitably engaged. The first difficulty concerns the technical lay-out of the farms, while the second is connected fundamentally with the pressure of population on land. The scope for mechanisation will therefore remain strictly limited in India until there is a thorough-going reform of the land system followed by an equitable re-distribution of land among cultivators and consolidation of holdings and farms.

It may well be argued that if co-operative cultivation is resorted to, the limitation imposed by the size of holdings or farms will cease to operate. This is no doubt true and reference will be made to this point later on. But this does not vitiate the above conclusion which refers only to the mechanisation of *individual* farms.

There is another point of technological importance which arises in this connection. What is the justification on technological grounds for mechanisation? Obviously there will be a case for the application of machine power if it can be demonstrated that the present technique of cultivation in India is unsatisfactory, whatever the size of farms. This is a point on which the agricultural engineers are best qualified to speak. Opinion is however sharply divided in this matter. One school of thought holds that mechanisation results in a more efficient cultivation of land and an increase in the unit-yield. Thus Lewis C. Gray writing on Agricultural Machinery in the Encyclopaedia of Social Sciences says 'The agricultural machine, like the industrial, represents a new, more rational, combination of the simple components of an operation originally performed by man. It does away with the quantitative or qualitative limitations of the human body. Efficient tillage machinery accomplishes more effective cultivation *resulting in a larger product per acre.*"* Against this view has to be weighed the opinion of some of the modern agricultural engineers who express doubt about the superiority of mechanical power in efficiency of cultivation. S. J. Wright, Director of the National Institute of Agricultural Engineering of the United Kingdom in an article on Farm Mechanisation writes, "One might go further and question whether tractors or engines have yet accomplished anything in any branch of farming which could not, in theory at any rate, have been done simply by using larger teams of horses. Nor is this an entirely theoretical point, for it is probable that the *most genuinely economi-*

* *Encyclopaedia of Social Science*, Vol. I, P. 552.

*cal ploughing ever accomplished by any means is that done in Australia with teams of eight or more horses pulling multi-furrow ploughs."**

It is obvious that mechanical power has very little to do with the mechanism of ploughing and other farming processes. Its technical superiority over the bullock or horse power is *only quantitative and not qualitative.* The increase in output and unit yield that is sometimes associated with mechanisation is therefore more to be ascribed to the agricultural implements and the accessories to the tractors and engines. It is certain that some of these implements are too heavy to be drawn by bullocks and animal power. But lighter machinery and implements, suitable on the one hand for small farms and on the other for draught by bullocks can be and to some extent have been invented. It is question of research on new lines in agricultural engineering. Mechanical power is surely something different from the agricultural implements and machinery and as such can be looked at separately. While therefore there is considerable justification for the introduction in India of improved agricultural implements like better plough the same can not be said in respect of mechanical power. In short, the technological conditions in India are not favourable to mechanisation of agriculture, and will remain so at least as long as the land system and the layout of the farms are not changed for the better.

Economic Pre-requisites: Historically the progress of mechanisation of agriculture in different countries of the world has been influenced, among other factors, by the supply of labour and level of wages. Shortage of labour due either to the lack of pressure of population on land or to the unattractiveness of agricultural wages in comparison with the industrial wages has influenced to a great extent the repid advance of agricultural mechanisation in Western Countries specially during the inter-war period. It is obvious that under these conditions the process of mechanisation in a country is not attended with social or economic dangers of a serious sort. On the contrary these are factors that are conducive to, and promote the application of machine power. Are conditions in India similar to these ?

India is traditionally associated with a heavy pressure of population on land. The per-capita area sown in India is the among the lowest in the world. Further this area has shown a steady decline in the past, as will be evident from the following table.† More concrete indices of the pressure

Year	Per capita Area (Sown Acres)
1911	0·90
1921	0·88
1931	0·82
1941	0·72

* Article on "Farm Mechanisation" by S. J. Wright in *Farming and Mechanised Agriculture, 1944-45*, Ed.—L. F. Easterbrook, P. 95.

† Final Report of the *Famine Enquiry Commission, 1945*, P. 78.

of population will perhaps be the area of the farm land per person employed in agriculture and the percentage of the population employed in agriculture. The following table gives these figures for some of the important countries of the World.

Estimated Proportion of Working Population engaged in agriculture and the net farm area per capita of agricultural population.

Country :	Percentage of people in agriculture to the total in 1939 or thereabout*	Net Farm Area per head of people in agriculture† Acres.
Great Britain	5·7	25·13
U.S.A.	19·9 (*a*)	35 (approx.)
Germany	17·9	
Canada	25·2 (*a*)	
Switzerland	20·8	
Australia	20·4	
Sweden	31·9	
Italy	20·4	
Japan	40·4	
India	66·6 (*b*)	1·22

It would appear from the above that the pressure of population on land and agriculture in India is perhaps the highest in the world. Consequently the supply of labour in agriculture seems almost unlimited. At least there is no immediate apprehension of a shortage of labour for agricultural operations and the consequent fallowing of land. In fact cultivable lands in India very seldom remain fallow for want of labour. Consequently one of the major incentives to mechanisation, viz., chronic shortage of labour for agricultural operations and the need for machines to take the place of man are conspicuous by their absence in India. Full utilisation of agricultural lands is therefore possible in India even without machine power. Besides, the cheapness of agricultural labour is another factor seriously limiting the profitability of mechanisation in India. These problems will be dealt with more fully in the section on economic consequences.

Mechanisation, as has already been pointed out, means investment of capital. It implies capital expenditure of considerable dimensions on tractors, engines and accessories. For example, a very light four-wheeled tractor with necessary accessories would cost about Rs. 4,000|- at present. This would perhaps be the smallest type of engine if the two-wheeled garden tractors are left out of consideration. It would be suitable for farms of area upto 50 acres. Accepting a more modest estimate of 40 acres for each such

* *Agriculture in an Unstable Economy*—T. W. Schultz, P. 87.

† Compiled and estimated.

tractor, the capital investment per acre amounts to Rs. 100|-. The question then naturally arises of the capacity of individual farmers to incur such expenditure on account of, what is called, *'farming'* capital.

An idea of the financial capacity of the farmers can be obtained from the present position of the capital investment on farms. The amount of capital of different forms at present invested per farm of each type and per acre would therefore be a useful index in this connection. There are however no statistics of this sort for India. Accordingly, the following figures obtained from the results of a Cost of Production enquiry conducted by Visva-Bharati Sriniketan in 15 villages are being taken as an approximate index for India.

Capital Invested in Farms in West Bengal in 1945-46

Class of Farm*	Aver. Area Acres	Value of capital invested on				
		Land	Cattle Shed	Bullocks	Implements & Accessories	Total
		Rs.	Rs.	Rs.	Rs.	Rs.
Per Tenant Farm ..	7·53	5647	140·4	665·5	144·2	6597·1
Per Cropper Farm ..	5·13	3078†	100·3	272·6	87·3	3538·2
Per Farm of all classes	6·30	4324	119·7	462·6	114·7	5021·0
Per acre of :						
Tenant Farms ..	....	750	18·6	88·3	19·1	876·0
Cropper Farms ..	....	600†	19·5	53·1	16·9	689·5
Per acre of Farms of all classes	....	687	19·0	73·4	18·1	797·5
Percentage	....	86·1	2·4	9·2	2·3	100·0

* The classification of farms is the same as that adopted by the author in his paper on "Cost of Production and Size of farms in West Bengal" referred to earlier. Tenant farms are those cultivated by hired, permanent, or contract labourers i.e. by persons other than the owners who act only as managers. Cropper farms are those which are cultivated and managed by the same person who in some cases is also the owner. Farms operated by Bargadars or by owners themselves mainly with family labour fall under the latter class.

† In the case of lands taken on Barga, the capital on account of land has been invested by the owner of the land, i.e. the Raiyat.

Farm property in the U.S.A. in 1945‡

	Average Area Acres	Value of capital invested on				
		Lands & Buildings.	Motor Vehicles used for production.	Other Machinery & Equipment.	Livestock & Poultry.	Total.
		$	$	$	$	$
Farm of all types	139	9145	354	402	1622	11523
Per acre of land	....	47.4	1.8	2.1	8.4	59.7
Percentage	....	79.3	3.1	3.5	14.1	100.0

‡ Estimated for the year 1945 from the figures mostly given in the Agricultural Statistics, 1945 (United States Department of Agriculture).

The above table reveals certain interesting features. It appears that in the year 1945-46 the amount of working capital (Bullocks and Implements) invested per farm was of the order of Rs. 577.3. Investments on the same account amounted to Rs. 809.7 per Tenant farm and to Rs. 359.9 per Cropper farm. The Tenant farms are therefore better placed than the Cropper farms with regard to the supply of working capital and this is quite natural, in view of the larger size of the Tenant farms and the better financial position of the tenants in comparison with the croppers. But even then Tenant farms look very poor and out of date against the average farm in America. In the United States of America, the value in 1945 of working capital invested per average farm of all types was $756 (roughly Rs. 2,520|-) inclusive of the value of work animals, i.e. animals used in agricultural operations. Out of this amount, motor vehicles used for production accounted for $354 (about Rs. 1,180) and other machinery and equipment for $402 (about Rs. 1,340). The figures for the U.S.A. given above do not, it must be remembered, accurately reflect the real situation in the matter of mechanisation, inasmuch as the value of working capital has been averaged for farms of all types including those which do not, by their nature, stand much in need of mechanisation. If however figures are worked out for Arable and Mixed types of farms, the value of working capital would be found to be much greater. These two types, it must be remembered, account for almost 99 per cent of all farms in India. Anyway, it is obvious that mechanisation demands a very large amount of capital investment, an amount much larger than the present volume of investments of working capital in farms in India. To bring Indian farms to the American standard, investments per farm on account of working capital would have on a conservative estimate to be increased at least five-fold from their present level. The figurs for West Bengal, needless to add, are here being taken as representative of India and the differences in the sizes of average farms in India and the U.S.A. are for the time being not taken into consideration.

It also appears from the above table that the value of working capital invested per acre of farm land in West Bengal in 1945-46 amounted to Rs. 107.4 in the case of Tenant farms, Rs. 70.0 in the case of Cropper farms and Rs. 91.5 in the case of the average farm of all classes. We have seen before that the cheapest and the lightest form of mechanisation suitable for farms in India would require investments at the rate of about Rs. 100|- per acre. Thus only in the case of Tenant farms the investment per acre is greater than this. It may therefore be argued that the owners and managers of Tenant farms only are in a position to mechanise their agriculture to the extent of using very light type of tractors provided other conditions are favourable. In other words, only those Tenant farms, the size of which is near about 40 acres or more are in a position to make capital investments for the purposes of mechanisation, and profit thereby through economics in

cost. Unfortunately, the number of such farms in India is very small. It has been found by the author * that in West Bengal farms above 100 bighas or 33 acres in size form 0.2 per cent of all farms and account for 1.7 per cent of the total farm lands. The number of holdings of this size, i.e. above 100 bighas or 33 acres is however greater. They form 1.2 per cent of all holdings and account for 8.2 per cent of the net total cultivated area. The division of large holdings into farms of smaller size caused firstly by the absence of mechanisation and secondly by the pressure of population explains this anomaly. The situation in India is in the nature of both cause and effect. It explains the small volume of working capital invested in farms and at the same time has itself resulted from the lack of financial capacity of the farmers for capital investments. The whole thing thus operates in a vicious spiral.

The next point to note is the comparatively small value of capital invested per acre of farm land in the U.S.A. The value of capital invested on motor vehicles for production amounted to $1.8 i.e. Rs. 6.0 per acre, that on other machinery and equipment to $2.1 i.e. Rs. 7.0 per acre and the total capital on these accounts amounted to $3.9 i.e. Rs. 13.0 per acre. Against these figures the value of capital invested on implements and accessories per acre in West Bengal looks more respectable, amounting, as it does, to Rs. 18.1. But this only reveals the defects of the technique of farming prevailing in India. It goes to prove that the greater the size of farms the more economical mechanisation becomes and the lower becomes the cost of capital per acre. This is also the case with capital invested on farm lands and buildings. Thus while the value per farm of farm lands and buildings (cattleshed in the case of West Bengal) amounted to Rs. 4,443.7 in West Bengal and $9145 i.e. Rs. 30,483.3 in the U.S.A. in 1945-46, the corresponding values per acre of farm land amounted to Rs. 706.0 and $47.4 i.e. Rs. 158.0 respectively. It is apparent that the larger size of farms in the U.S.A. where the average size is 193 acres, as well as the lack of pressure of population are factors responsible for this low value of land and building capital per acre of farm land, as compared with that for India.

The last point to note in this connection is the proportion of different forms of capital. In West Bengal land and cattleshed absorb 88.5 per cent of the total capital invested in farms, while bullocks account for 9.2 per cent and implements and accessories for 2.3 per cent. But in the U.S.A. land and buildings account for 79.3 per cent of the total value of farm property, motor vehicles for production for 3.1 per cent, other machinery and equipment for 3.5 per cent and livestock and poultry for 14.1 per cent. The comparatively smaller share of land and buildings in the total farm capital as well as their low value per acre in the U.S.A. are therefore striking and

* Cost of Production and Size of Farms in West Bengal by J. P. Bhattacharjee, Pp. 4-5.

constitute one of the factors responsible for the spread of mechanisation in that country. For a high level of land prices proportionately reduces the capacity of the farmers for investment on working capital. It is significant that of the total capital invested on farms in West Bengal in 1945-46, 86.1 per cent was on land alone. This is perhaps natural in an over-populated country. But it indicates at the same time the urgency of measures to check the boom in land prices at least in the interests of improvement of capital equipment of farms.

The main problem does not however rest there and is ultimately linked up with the capacity of farmers to incur fresh capital expenditure of some, if not considerable, dimensions. The value of capital investments in different countries and under different heads is at best an unreliable index of the financial capacity of farmers for making fresh outlays of similar amounts. In fact it is highly doubtful whether the average "Tenant farmer" cultivating his 7.53 acres of land would be able to spend, say, Rs. 3,500/- at a time for buying a tractor and accessories. And the tenant farmers are better off than the "Cropper farmers." For the average farmer mechanisation is thus something beyond his reach. Its financing can therefore become possible only in the context of co-operative ownership of capital and co-operative investments. The need for this co-operative approach to the financial and technical aspects of mechanisation is all the more great in a poor and densely populated country like India.

Such then are the objective conditions in India. The factors limiting the scope and the profitability of mechanisation of individual farms in India are too large in number and too formidable in magnitude. These limiting factors restrict the possibility of mechanisation to only 0.2 per cent of farms and 1.7 per cent of the farm lands in West Bengal under the existing circumstances. But if the farms are re-organised so as to give rise to one farm per holding without involving any change in ownership rights, the possibilities can be extended to 1.2 per cent of holdings and 8.2 per cent of the cultivated area. More ambitious and large scale reforms will perhaps alter the situation. In the meantime however there is scope for mechanisation of farming and agriculture on a co-operative basis.

II. Economic Consequences.

Let us now turn from the real to the hypothetical and imagine that agriculture in India has been fairly though not fully mechanised. What would then be the effect on the rural and the general economy of the country? If other things remain the same, there would obviously be a series of repercussions first of all perhaps on labour, then gradually extending into other sectors. For mechanisation is not simply a change-over from the use of human and animal power to that of mechanical power in agricultural opera-

tions. It symbolises profound changes in the technique, organisation and system of farming and consequent reactions on the rural and agricultural economy of the country. Let us then turn to these repercusions.

Wages and Costs. Mechanisation is a method of increasing the efficiency of application of power, every farming operation being more or less an application of power. It is therefore a method of increasing the efficiency of labour in agriculture and raising the agricultural production per worker. By its nature, it reduces the quantum of labour required to produce a unit of output. In the U.S.A., the amount of "human labour used to produce 100 bushels of wheat dropped from 320 hours in the year 1830 to 108 hours in 1900; by 1940 a new series of improvements has reduced this labour requirement to 47 hours."* In the course of 110 years therefore mechanisation has brought about an economy in the use of labour per unit of output to the extent of 85.6 per cent. It thus changes the cost structure of farms. This point can be illustrated by comparing the production costs of farms in India with those in the U.S.A. The following table, based on the results of a cost of production enquiry conducted by Sriniketan in 1945-46, shows the composition of farm costs.

Composition of farm costs (Cereal farms) in West Bengal in 1945-46.

Items	Cost per bigha Rs. a. p.	Percentage
Seed..	1 7 0	3·7
Manure	2 12 9	7·1
Labour	15 2 6	38·4
Bullock	16 1 3	40·7
Implement	1 13 3	4·6
Marketing	0 8 3	1·3
Other costs	0 2 6	0·4
Rent	1 8 3	3·8
Total ..	39 7 9	100·0

It appears from the above table that labour, and Bullock and Implements costs i.e. cost of human and animal power account for 83.7 per cent of the total costs. In the U.S.A., however, the labour and investment furnished by the operator (of farm) and his family make up slightly more than half the total cost on most types of family operated farms.† The composition of costs is however not a good index of the amount of labour used. The rate of wages influences the labour cost. Consequently, the effect of mechanisation has to be studied with reference to the quantum of labour required to produce a unit output and the level of wages. As regards the former it is difficult to say anything at the moment. Suffice it to say that

* Article on Farm Science and Citizens by Sherman E. Johnson in Science in Farming-Yearbook of Agriculture, 1943-47 (U. S. Dept. of Agriculture) P. 922.

† The Farm Cost situation, Bureau of Agricultural Economics, U. S. Dept. of Agriculture-September 1946, P. 28.

mechanisation can reduce the labour requirement of farms immensely. This will be apparent from the fact that the gross farm production per worker in the U.S.A. in 1945 has increased by 37 per cent over the 1935-39 average, thanks mainly to mechanisation.

Mechanisation therefore makes possible the raising of wage rates by reducing the use of labour. In fact one of the main impulses to mechanise in most countries of the world has come from the high price which had to be paid for agircultural labour. Conversely, low rates of wages prevailing in any country act as a deterrant in this matter. "In most parts of Europe", to quote from Yates and Warriner[1], "it has been impossible to mechanise to any considerable degree owing to the low rates of agricultural wages." Cheapness of labour is one of the unfortunate consequences of over-population and India is a chronic sufferer from this malady. The extent to which mechanisation will be profitable in India is a matter of calculation. It can however be safely assumed that at present when agricultural wages have increased by more than 200 per cent over the pre-war level, and when the efficiency of labour in India has on the whole not improved over, rather fallen below, the pre-war standard, mechanisation has become a profitable proposition, at least for farms which can use medium-sized tractors. Calculations show that the cost of cultivation with a 12 H.P. Tractor comes to about Rs. 14/- per day, including depreciation. The tractor would plough about $3\frac{1}{2}$ acres in a day or about $7\frac{1}{2}$ bighas. Calculating on the basis of 7 bighas, the cost of ploughing per bigha comes to about Rs. 2/-, against the prevailing rate of Rs. 4/- to Rs. 5|- for ploughing a bigha of land with bullock. Machine ploughing is therefore definitely cheaper now. If however the rate of wages goes down again to the pre-war level, this view will perhaps have to be modified.

But the rates of wages now-a-days do not move according to the natural laws of economics. Full employment and economic security demand a rising rate of wages in all lands, more so in the under-developed countries. And mechanisation is a boon in this respect. It enables the farm operator to raise the level of agricultural wages. The issue is thus clear that the predictable course of agricultural wage level in India in future as elsewhere leads us more towards mechanisation. This seems to be a general tendency or trend.

Output and Price level. Taking up the line of discussion of the previous paragraph, it may be said that the issue of mechanisation is further mixed up with the question of price level. The experience during the last depression shows that agricultural prices are most hard hit during a slump. Again during a period of rising prices there is always a demand from the consumers i.e. the people for lowering agricultural prices, and the cheapen-

1 Food and Farming in Post-war Europe by P. Lamartine Yates & D. Warriner. P. 70.

ing of food. It is unlikely therefore that agricultural prices can be or will be stabilised at a high level. Wages will not however be reduced in the same proportion in that the demand for its increase will always be there. India will therefore find herself in the not distant future in the position in which countries of Western Europe and America are finding themselves now. The gap between agricultural wages and price-level, between the price received for agricutural produce and the production cost will go on increasing. This gap can be bridged only in two ways, firstly by absorbing the landless working class in other occupations and redistributing land to families on the basis of economic units and secondly by the adoption of mechanisation. At this juncture the first remedy sounds more practical and important. The second one should be reserved by all means for the future.

It has been mentioned in the first part of this paper that it is debatable whether mechanisation increases the yield of land or the output per unit of area. Sherman E. Johnson*, Asst. Chief of the Bureau of Agricultural Economics, U.S.A. holds that of the 28 per cent increase in farm output in the U.S.A. above the average of 1934-39, "only about a fourth is due to better weather, probably less than 15 per cent has resulted from expansion of crop land acreage and the rest, about 60 per cent, is largely accounted for by fuller use of the improvements in crops, livestock and machinery." It is better not to step into this controversy here. But on the assumption that mechanisation increases yield, it seems a very desirable thing in India where the annual deficit of food grains amounts to between 2 and 3 millions tons. India is not faced like the under-populated countries with the problem of over-production and consequent lowering of prices. There is therefore no danger of a competitive lowering of agricultural prices in India from mechanisation. It will not of itself go to lower agricultural prices and thus reduce their returns. The prices will as usual depend considerably on the general economic situation.

From this point of view mechanisation is very desirable and seems to offer the only method of bringing into cultivation large blocks of cultivable waste lands and fallows. As for the existing farm lands improvement in yield will have to be effected, for reasons stated in other sections, through other measures like use of improved seeds, provision of irrigation facilities, liberal use of manures, adoption of proper systems of rotation of crops and better cultural practices. In other words, India should, like China, rely more on "Conservation Farming" in order to attain an increase in yield.

Supply of Labour. Mechanisation of agriculture is usually associated with countries in which the supply of labour for agricultural operations is rather inadequate, e.g., Canada, Australia, Argentina, Russia and U.S.A. The situation in India is just the opposite. There is no dearth of labour in

* Ibid, P. 926.

this country, specially in agriculture. Apparently therefore, mechanisation will only serve to intensify the problem of rural unemployment. But though it is true that there is an overall surplus of labour in India, it may at the same time be equally true that there is an acute shortage in certain seasons and for certain agricultural operations. Anyone having some knowledge of rural conditions will be able to certify that during the sowing and the harvesting times in the Kharif season there is shortage of labour caused by a heavy demand and resulting in a temporary increase of about 50 per cent, in agricultural wages. It is difficult to say with any measure of accuracy whether this shortage is real. An attempt is however being made here to estimate the shortage, if any with reference to a particular district.

The total area under Aman Paddy in the district of Birbhum, West Bengal, is between 611,000 and 631,000 acres. The average area may therefore be taken to be 620,000 acres, or 1,860,000 bighas. It has been found out from the results of a cost of production enquiry conducted by Sriniketan in 1945-46 that the amount of labour required to harvest 1 bigha of Aman paddy is on an average 3.13 man days. The total labour requirement for the harvesting of Aman paddy in the district of Birbhum therefore amounts to 5,821,800 man-days. It is a fact well known to the agriculturists that this harvesting should be spread over more than 15 days if a good quality and yield of grains is to be obtained. Assuming a longer harvesting period of 21 days i.e. three weeks, the total number of workers required for the harvesting of Aman paddy in Birbhum amounts amounts to 277,228. Let us now find out the number of agricultural workers available in Birbhum. Estimating on the basis of the results of an Indebtedness Enquiry* conducted by Sriniketan in 1944-45 and the 1941 Census figures, the number of persons engaged in agricultural work in 1941 amounts to 247,868. This figure is arrived at by finding out the total number of families in the district, and then obtaining the number of families engaged in agricultural operations and from this calculating the total number of agricultural workers. The position of labour supply in Birbhum for harvesting operations is stated below in a tabular form.

Labour supply and Requirement for harvesting of Aman Paddy in Birbhum, West Bengal.

Period of harvesting	Required No. of workers	Available supply of workers	Shortage (—) or Surplus (+)
15 days	388,120	247,868	— 140,252
21 days	277,228	247,868	— 29,360
30 days	194,060	247,868	+ 53,808

* Vide Rural Indebtedness in Birbhum, West Bengal, a Re-survey by J. P. Bhattacharjee, Visva-Bharati Economic Research Publication No. 4.

It appears therefore that unless the harvesting operations are spread over 30 days, there will be a shortage of labour in Birbhum. With a three-week harvesting period, the shortage of labour amounts to 29,360 persons or about 12 per cent of the supply or 11 per cent of the demand.

It is in such seasons and for such operations by nature limited in time that mechanisation offers the only solution to the problem which faces the agriculturists. Such contingencies again are not just a few, neither are they rare. Harvesting of paddy, wheat, jowar, bajra, etc., irrigation of crops, crushing of sugarcane and the like are some of the farm operations in which mechanisation will solve the labour shortage usually encountered. It is in these restricted and specialised spheres of farm operations that the adoption of mechanical power has immediate possibilities in India. Needless to add, such mechanisation will have to be brought about through co-operative agencies and organisations. But in each case of such partial mechanisation, its economics will have to be completely worked out and a plan for the full exploitation of the machines with a view to obtaining low overhead costs drawn up, before mechanisation is actually taken in hand.

Employment. Mechanisation is a method of saving labour, or in other words economising the use of human and animal labour. Its most important effect is therefore on the demand for labour in agriculture. It reduces the amount of labour required to produce a unit of output. It has been seen that in the U.S.A., it has reduced the demand for labour in the cultivation of wheat by 85.6 per cent during the last 110 years. In a developing country with plenty of land to go round, this may not become a problem; but in an over-populated country like India such a situation is fraught with the gravest of dangers. It raises problems of employment which are by no means easy to solve. It is difficult to make any estimate of the number of persons who will be displaced from farm occupations as a result of the adoption of mechanical power. That will depend on the extent of mechanisation and the size of the farms. Besides there are no statistics of the existing volume of farm employment in India and it is commonly known that the agricultural workers in India are usually under-employed.

Mechanisation will affect employment in two ways, first of all through the re-organisation of farms into bigger units accessible by the technical demands of mechanisation and secondly by the displacement of labour. It is obvious that enlargement of the work units is a condition precedent to mechanisation. Mr. Tarlok Singh* has estimated on the basis of 1941 Census figures that as a result of rationalisation of agriculture on the basis of the existing work units and joint village management, about 15.5 million agricultural workers representing about 28 per cent of the total population would be forced out of their present employment in British India. This estimate is based on the assumption of (a) different sizes of work units

* Poverty and Social Change-Tarlok Singh, Chapter V.

for different provinces, the units varying from 7 to 20 acres and averaging about 10 acres for the whole of India, and (b) of an available employment of 1.5 workers per unit. Mr. Singh does not envisage any mechanisation of these units for the present. It is however obvious that even these re-organised units are not sufficiently large to make mechanisation profitable. On the basis of 40-acre work units, the surplus agricultural population would be at least double this figure i.e. at least 31 million persons, representing on the basis of past figures for British India about 55 per cent of the total population. Added to this will be the number of persons for whom there will be technically not much of work on the farms to employ them fully, the mechanisation having reduced them to the category of mere part-time workers. Even on the most liberal estimate, such part time unemployment will affect another 5 per cent of the population. In all therefore about 60 per cent of the population will be forced out from farm occupations. And this is a reasonable and conservative estimate. It may be mentioned here that in the U.S.A. total farm employment declined from 11,289,000 persons in 1929 to 10,852,000 in 1934 and 10,037,000 in 1945[1]. The decline between 1929 and 1945 is of the order of 10 per cent and due mainly to increasing mechanisation of farms, and this has happened even inspite of the encouragement received by the "Family farms".

How can these people be rehabilitated? A corresponding increase in non-farm employment is the obvious answer. This means the creation of employment in secondary and tertiary industries to the extent of absorbing by far the major portion of natural growth of population plus the displacement of persons from agriculture. Whether such an expansion of industries and of individual employment can be made within a reasonable period is however problematic. In 1941 there were about 16.3 million persons employed in industries in India, in other words about 9.6 per cent of the working population was engaged in industries. To raise this percentage to about 50 within say 15 or 20 years would seem a pious and unreal wish. At least this would be impossible under the capitalistic plans drawn up for India by the Bombay Industrialists or lately by Mr. Birla himself. According to the most liberal estimates of the Bombay Planners, the percentage of working population that will be employed in industries in 1962 would amount to 26.9 only. Besides, they hope to find profitable employment for 123.7 million people in agriculture only, 23.4 million more than were engaged in it in 1931. In other words the Bombay Plan, and in fact most of these plans of the Capitalists do not envisage a reduction of the number of people depending upon agriculture for livelihood. These are mostly industry-centred plans with agriculture playing the part of the beast of burden. It is rather unfortunate that the Government of India is more or less following the path set forth by the Bombay planners. The future of

1 Agricultural Statistics, 1945 (U. S. Dept. of Agriculture).

farm and non-farm employment in the country is thus gloomy indeed.

It is obvious therefore that under the plans of the capitalists, it will be impossible to absorb in industries persons displaced from land on account of mechanisation of agriculture. Even in a rich, industrialised and less densely populated country like the U.S.A., there is still the problem of under-employment and unemployment in agriculture. Prof. T. W. Schully estimates that "the migration out of agriculture (due to industrialization for war), particularly out of the poorer farming areas, has not and will not have proceeded anywhere near far enough for the earnings of at *least one-third, more likely one-half,* of the people engaged in farming to reach a level comparable to the earnings of the less well-paid labour in other occupations."* The mere expansion of industries on a capitalistic basis would not therefore solve the problem of unemployment caused by mechanisation of agriculture. At the same time it is doubtful whether the problem can be fully solved through a socialistic form of planning. It is true that a socialised economy would enable the establishment of a proper balance between industry and agriculture. But even then it would in India at least be unable to stand the full strain of mechanisation of agriculture and the consequent displacement of labour. From the point of view of employment therefore it would be better to follow a slow policy in the matter of mechanisation and to co-correlate its speed with the progress of industrialisation. In other words, the progress of mechanisation in India will have to be determined with reference to two factors, firstly the rate at which surplus labour can be transferred from land to other occupations and secondly, the rate, as we have already seen, at which agricultural wages can be raised. At the moment, however, the ground should be prepared by giving effect to the more urgent agrarian reforms like the redistribution of land and the re-organisation of farms into larger more efficient and economic units.

Farming. Mechanised agriculture is primarily associated with grain-farming of an intensive nature in western countries. It has resulted in "notable geographic shifts towards lands of relatively level topography, particularly to cheap lands of low rainfall in Canada, Australia, Argentina and western parts of the U.S.A., which could not be cultivated economically under more laborious methods."** Such a geographic shift would however be desirable in India where there were in 1942-43, 110,932,000 acres of relatively level culturable waste lands which were equivalent in area to about 40 per cent of the net sown area. The food situation in India demands that these lands should be immediately brought under the plough through the use of tractors, bull-dozers and other machines. It is in this job of reclaiming waste lands at the cheapest cost that machines and mechanical power have immense possibilities in India. Obviously, a huge number of

* Agriculture in an unstable economy-Theodore W. Schully, P. 109.

** Encyclopedia of Social Sciences-Vol. I. P. 556.

tractors and engines have to be purchased for this purpose. These machines serve not only to reclaim these lands by means of deep ploughing, eradication of weeds and breaking up of lands, but subsequently to cultivate them. State or Collective Farms will have to be organised for this purpose on these lands. Needless to add, heavy types of machine will be necessary for this purpose.

The food and agricultural situation in India demands that on the existing cultivated lands the method of intensive farming should be adopted and the return from land thus augmented. This is possible only if further capital is invested for the improvement of land and the extension of irrigation facilities. Improvement and extension of irrigation facilities mean not only the construction or repair of the sources of water, but also its distribution. And in both these respects power machinery has immense possibilities in India. The present method of lifting irrigation water in India by means of bullocks is inefficient and costly. The earlier human and bullock power is replaced by mechanical power (power pumps or motors) in these operations the better not only for agriculture but also for the country. The similar need for the introduction of machines in other special operations of farming has already been pointed out in the section on supply of labour. It may be mentioned here that all these machines should be of the smaller, light type such as would be suitable for intensive farming. The one thing that should be guarded against is this that mechanisation does not encourage extensive farming through the tendency towards a merger of farms into a few hands. The cost aspect has of course always to be considered.

The most important effect of power machines on farming is perhaps on the cropping system. In the past as has been mentioned mechanisation has been found to be most suitable to extensive grain-farming. This type of farming has a low money output per acre and is thus unsuited to a crowded country like India, which needs an increased acreage of crops achieved through the system of double or treble cropping. In such a plan for intensified farming the acreage of money as well as fodder crops should be considerably increased. Such a change in the cropping system will be facilitated in India at least by the use of power machines in place of bullocks. It is a fact that the pressure of population on agriculture forces the farmers to cultivate the more labour consuming crops. They can be prevented from this wasteful method of cultivation only by mechanisation. It is also a fact that the draught animals, bullocks and buffaloes, in India consume by far the major portion of the feeds, roughage and concentrates given to the bovine population and that the number of work animals is in some areas disproportionately high. According to the Livestock Census * of 1940 there were 51

* Livestock Statistics, 1940, Govt. of India.

million work cattle and 5.3 million work buffaloes in India, against a total buffalo population of 22.4 millions. It appears therefore that more than 50 per cent of the total bovine population consists of work stock. It is true that the World War and the famine have reduced the number of cattle in some areas considerably and thus affected agricultural operations adversely. In such areas the need of machines to take place of bullocks has become rather urgent. But even apart from this the existing number of work stock is unduly high. Unless this number can be reduced, neither the feeding of the milch cattle nor their milk yield can be improved. In view of the tremendous shortage of milk in India, the reduction in the number of work animals so as to make for an improvement in the performance of the milch animals should receive a very high priority from the Government. One way of doing this is to replace work animals by machines, while another is to improve the working capacity of the animals. It is true that the first measure can not be immediately implemented because of its widespread repercussions. But a reduction of 10 per cent in the strength of bullocks through mechanisation can be safely planned for the next few years. The latter measure should however be pushed through at a rapid pace. The attendant danger of a reduction in the supply of cowdung, it may be mentioned, is more apparent than real. For the amount of fodder and feeds that will be given to the cattle allowed to exist will be much greater than the total amount now being consumed. It is in this way that the pattern of agriculture will also be changed. There will be more emphasis on fodder crops which if judiciously planned and rotated will go a long way to replenish the fertility of the soil.

Economic Structure. Mechanisation has always resulted in a shift from subsistence or peasant farming to commercial agriculture. This shift occurs mainly due to the need for more land and capital to be associated with each farmer in order to reap the full benefits of technology. This in its turn gives rise to two tendencies in the agricultural economy, (a) gradual replacements of domestic or family by commercial and capitalistic methods and (b) search for international markets for the agricultural produce. Conditions in India will not favour such changes in the economic structure. But still these tendencies have to be guarded against. The best way of doing this is to go in for co-operative farming. As the Famine Enquiry Commission has recommended, "the only hope of placing power machinery for cultivation within reach of the vast majority of cultivators is by co-operative effort, or by a system under which ploughing and other operations are carried out by contractors on a contract basis."[1] Amongst these two methods, the co-operative way is of course the best and perhaps the only way that can be adopted in a crowded country like India characterised by small holdings. The danger of substitution of world markets for local markets on the

1 Final Report of the Commission, P. 169.

other hand does not exist in India which is a chronic sufferer from shortage of food and where the internal demand is always in danger of exceeding the supply.

Mechanisation affects the economic structure in another way. It improves the efficiency of agriculture, brings it more in line with industries and thus helps to attain a parity and equilibrium between these two sectors of the economy. This is also a vital consideration in an age in which the output, wages and incomes in industries are increasing at a tremendous pace. Unless similar improvements are also effected in agriculture, the disparity between agriculture and industries will go on widening always to the detriment of the former. Mechanisation will help to bridge this gap by changing the output, wages and incomes in agriculture and thus bring about a parity between agricultural and industrial prices. From this point of view also mechanisation is a desirable reform in the agrarian economy of all countries including India.

Lastly, mechanisation will result in a significant modification of the social structure in rural areas. It will free the farmers from much of the laborious, tedious and hard work on farms. Life will become more beneficial and the standard of living will rise. There will be less people on land and the status of the agricultrists will improve. Occupational classification of the rural population will undergo a profound change. Simultaneously there will be an all-round development of rural areas. Trade and transport will increase and there will be less dependence on the vagaries of the local markets. Mechanisation of farming is thus linked up with rural electrification and development of roads. Without the latter the full benefits of the former cannot be enjoyed. In other words, a policy of mechanisation for its success depends on the extension of cheap power to rural houses and construction of good roads and extension of organised trade and banking facilities to rural areas. All these, in their turn, depend upon the accomodation which the industries offer to the rest of the economy.

The economic consequences of mechanisation of agriculture are therefore complex and varied. There are good points in it as well as bad, chances of gain as well as risks of danger. Both these sides have to be remembered while formulating a national policy on this issue.

III. Summary and Conclusion.

Let us now make an attempt to draw conclusions on mechanisation of agriculture in India. It is obvious that a lot of ground has been covered and a number of conflicting views put forth. An attempt should therefore be made to strike a balance between these views and estimate the weight of the arguments put forward on each side.

In the section on Conditions and Pre-requisites, we have seen that the technical conditions of land and holdings in India are at present unsuited to

mechanisation. Firstly there are too many plots of very small size which will make it impossible for machines to operate. This problem of 'parcellement' and fragmentation of land has got to be solved through consolidation of holdings by co-operative or other methods before mechanisation can be taken up. Secondly, the small size of holdings in India will make mechanisation of individual farms most unprofitable. Thirdly, it is doubtful whether mechanisation increases the output or the unit-yield of crops and even if it does, the increase in yield is to be attributed to the implements and accessories attached to the power machines. While therefore there is every reason for the introduction of improved implements in India, the case for the adoption of mechanical power is not so strong or convincing.

The economic conditions in India are not also favourable to mechanisation. The first and perhaps the main reason is that the pressure of population on land and agriculture in India is among the highest in the countries of the world. Consequently, the supply of labour in agriculture is almost unlimited and agricultural wage level very low. These factors seriously limit the profitability of mechanisation in India. Secondly, the economic and financial capacity of the farmers in India is not sufficient for the adoption of power machines. The investment of working capital per farm that will be needed will be beyond the financial capacity of the farmer, even though the investment per acre will be lower. The high land values in India also constitute a factor limiting the investment capacity of farmers. Even though the investment on working capital per acre of tenant farms in West Bengal is higher than the corresponding figures for the U.S.A., it does not indicate any ability or capacity on the part of these farmers to make fresh outlays of similar amounts per acre on power machines.

The objective conditions in India therefore restrict the possibility of mechanisation of individual farms to 0.2 per cent of farms and 1.7 per cent of farm lands. If however farms are re-organised without any change in ownership, the limit may be raised to 8.2 per cent of the cultivated lands. The more urgent reforms in India are the reform of the land system, an equitable redistribution of land among cultivators and consolidation of holdings and farms. These should precede any attempt at mechanisation either on individual or co-operative farms.

In the section on Economic Consequences, the effects of mechanisation on wages and costs, output and price-level, supply of labour, employment, farming and economic structure in India have been analysed and found to be a curious admixture of good and evil. Among the good effects may be mentioned (a) raising of the level of agricultural wages brought about through changes in the cost structure, (b) an economy in the cost of production calculated on the basis of the existing level of agricultural wages, (c) one way of bridging the gap between the wages and the price-level, (d) an

increase in output without much adverse effect on the price level, (e) smoothening out of the peaks of labour requirement and shortage in certain seasons, (f) a level of efficiency in certain agricultural operations, difficult to achieve with the present technique, (g) a shift towards cultivation of culturable waste lands, (h) greater efficiency in intensive farming, (i) adoption of a system of cropping which will result in a higher money output per acre, more and better food for the people and greater fertility of land, (j) attainment of a parity between the agricultural and the industrial sectors of the economy, (k) a modification of the rural social structure resulting in a higher standard of living.

Among the bad effects of mechanisation are (a) displacement of labour from land and the consequent fear of unemployment which is very real in a country like India, (b) tendency towards capitalistic farming as mechanisation strikes at the root of peasant or subsistence farming, (c) consequently the growth of a landless proletariat class, (d) slump in agricultural prices caused by a revolutionary change in the nature of the supply.

It is obvious therefore that the policy on mechanisation should be very carefully planned. Power machines are no doubt a boon to the farmers and if their evil effects can be eliminated they will surely revolutionise Indian agriculture. What is needed therefore is a policy directed to this end. The first step is a thorough-going reform of the agrarian economy. The agrarian reforms will be directed towards the establishment of State farms on State lands, Collective farms on lands of poor quality and the cultivable wastes, Co-operative farms on the less densely populated areas and individual farms of an economic size in other areas. The ground would then be prepared for the second stage. It will then be the time for mechanisation of the State and Collective farms to be followed gradually by that of the Co-operative farms, as and when these are organised and the possibility as also the profitability of such a measure fully demonstrated and established. The speed of mechanisation will have to be determined, as already pointed out, by (a) the speed with which the surplus labour can be absorbed in other occupations and (b) the speed at which agricultural wages can be raised.

The type of machines that will be needed will depend on the nature of the work for which they are to be used. Development of waste lands will require rather heavy types of tractors while arable lands will need, in the special conditions of India, lighter types. Unfortunately, efficient machines of the lighter types have not yet been perfected. Research work on these lines has therefore to be carried on by agricultural engineers. It may be worthwhile in this connection to quote a very able suggestion of Lamartine Yates, and Warriner, "If the first era of agricultural machinery was characterised by size, second era on which we are entering appears to be devoted

to evolving small machines for the small man."* The suggestion applies as much to Europe as to India. Besides, the peculiar circumstances of India demand that the form of mechanisation suitable to the country should be one which replaces only animal power and not so much human labour and power. Whether power machines of a light type capable of replacing bullocks more than men can be invented is however a matter for the engineers.

India will need a very large number of tractors if a policy of mechanisation is adopted. In 1940, according to the Livestock Census, there were in the whole of India, only 6,556 tractors and 11,244 Oil engines with pumps for irrigation purposes. The number looks very small indeed when we remember that in 1945 there were 2,425,000 tractors in the U.S.A. and 179,850 tractors in England and Wales. There was therefore one tractor in the U.S.A. for 437 acres of farm land and in England one for 135 acres. For the development and cultivation of waste lands alone there will be needed in India about 250,000 tractors if we calculate on the basis of one tractor for 400 acres. The number of tractors that will be needed for the mechanisation of the existing farm lands if and when that is made possible will also be very large. Besides there will also be a huge demand for oil engines with pumps for irrigation purposes. It is time therefore that the Government of India should try to establish a tractor industry in the country in the near future and train up as many technicians and mechanics as possible. It must be remembered that without this industry and without these men, any scheme of mechanisation in India is bound to be unprofitable and ultimately fail.

Finally, a reference should be made to the fundamental problems revealed by this analysis. Considerations of decency and humanity demand that the status and living conditions of farm workers should be improved and their wages raised at least to the level of industrial wages. Technology may make possible the raising of these wages through more and more mechanisation. But industries by their nature admit of a much greater degree of inventions and improvements than agriculture. Consequently agricultural wages will always lag behind industrial wages and the very profitability of agriculture may be at stake from demands for wage increases. Besides there is always a limit to agricultural mechanisation. This limit is set, apart from internal factors, by the capacity of industries to absorb surplus labour from land. In a race for technological advances this limit becomes lower and lower in industries also as is now evident in Western countries where the percentage of people engaged in industries has stopped increasing. Ultimately, we have either to cry halt to technology or be satisfied with a state-subsidised agriculture. The prospect is dark indeed. And this is one of the many contradictions in capitalism which it will perhaps fail to solve.

* Food and Farming in Post-war Europe by Lamartine Yates & D. Warriner, P. 75.

MECHANISATION OF AGRICULTURE

By

MRS. MEHROO JUSSAWALLA

In India agriculture preponderates over all other occupations. With 67.2 per cent of her population engaged in agriculture it should be given prime priority over all other problems. No advance commensurate with what has been achieved elsewhere in the science of sowing and reaping and gathering has been made in this country. Apart from the vagaries of rainfall the cultivator finds that the industry is not a commercial concern. The agriculturist forms the backbone of our national economy and we cannot afford to neglect his lot. What with the food position deteriorating rapidly and the experiences of the Bengal famine still fresh in our memory, an endeavour must be made in all directions to solve first the knotty problems confronting our agricultural economy in these critical times. The primitive method of cultivation is chiefly responsible for the depressed condition of agriculture. There seems no hope for the country's starving millions unless the technique of cultivation is completely revolutionised to intensify production and to mitigate the effect of seasons on employment. Every country in the West that underwent rapid industrialisation had to grapple with the problem of stepping up primary production. It will of course be fantastic to suggest immediate implementation of a plan for mechanising agriculture in India. We must however make a start and the sooner the better. To banish poverty, to make want under any circumstances unnecessary and to provide a minimum level of well being for the people are some of the targets aimed at today. As the I.L.O. has rightly declared "poverty anywhere constitutes a danger to prosperity everywhere." It was only during the last World War when foreign imports were stopped that agriculture began to get its rightful place in the country's national economy. Today the public and the press stress the need for more modern power-operated tillage tools.

Attempts at mechanisation have been made in this country in the past. In 1919 after the first World War several wealthy farmers began to adopt modern methods and several tractors were purchased. The benefits that accrued were negligible and when the depression came the tractors were left to rust. In those days the price of the crop did not even pay for the oil the tractor consumed. In 1932 the protection given to the sugar industry produced the necessary incentive for intensive cultivation. Cane growers needed deep tillage instruments and bought tractors for the purpose. Once again attempts were made at mechanisation in Bombay, Hyderabad (Deccan) and Sind where valuable data was collected. Still Government was not interested on the whole in mechanisation. Then came the Second World War during which the tremendous possibilities of agricultural machines were

opened up and the need for a thorough overhaul of our agricultural practices became underlined. The Grow More Food Campaign was initiated. At long last, Government began to awaken to the important role of mechanisation of agriculture.

The Need for Mechanisation

The present pressure on land and congestion in Indian agriculture are evils which cannot be overcome by expanding industrialisation alone. There is a demographic pressure on agriculture in most of the provinces specially Madras. This has led to excessive splitting of peasant properties and agriculture has been placed on a deficit economy. Even if industrialisation advances very rapidly through the establishment of large-scale industries, no less an authority than Sir Visweswaraya guages that at the utmost we can expect an increase absorbing from 35 to 45 millions. Thus only one fifth of the people can be absorbed leaving 4|5th to eke out their livelihood on land. Thus no one can deny that raising the productivity of the soil through enlarging the size of the economic holding and the application of modern methods of cultivation are the preliminaries to rural prosperity and full employment.

If adequate food supply for the country is to be ensured a larger capital outlay for agriculture is essential. The ghastly famine of Bengal has brought home to the country the precarious food situation. The phantom of a similar situation haunts us today caused by the floods from Assam to East Punjab and the scarcity in Cutch, Saurashtra, and Gujarat. This makes the urgency more impelling for improving the input on land if the best output is to be had. The Food Minister himself made known that we spend one anna per head on agriculture against as much as Rs. 80 in the U.S.A. Of course we cannot afford to spend as much as the U.S.A. because our income and rate of capital formation are not equal to theirs. But we can do a great deal with a limited expenditure.

Agriculture as it is practised today is merely a subsistence industry, for what the husbandman produces is just sufficient for himself and his family. There is no measurable surplus to supply the market. This is because his mode of cultivation is out of date, the capital resources at his disposal are meagre and there is hardly any organisation on such a small holding. The cultivator is consequently not interested in the soil or its output but only in the remuneration he receives for his single marketable faculty namely his physical labour. Such labourers naturally are susceptible to exploitation and harassment at the hands of the zamindars. There are today 67 millions of such landless labourers in India. The only possible cure seems to be an emulation of the Russian system of collective farming with mechanisation on such collective farms. As the Economist rightly puts it "the real cure is an economic revolution in the country as wide ranging and

drastic as the modernisation of Russian agriculture with state capital." The Government should remove the stupor stalemate in the agricultural world with a vigorous drive to accelerate the process of new ways and means.

The diversified economic system which exists in the country has its repurcussions on the efficiency of agricultural production. Industrial employment has become more attractive and entices able bodied labour towards industries. But in industry all the factors of production are competitive including labour. In agriculture labour is non-competitive with other factors of production and capital too has so far remained stationary unless mechanisation can be made to bear tangible results. Our efforts should be directed towards reducing the rigidity of the factors of production in an already too rigid agricultural economy. Our plans for the future should be to increase the tempo of production and through mechanisation to make the factors of production competitive.

The revolution which the land system in the country is witnessing has pushed the problem of mechanisation to the fore-front. Share farming and tenancy farming have been in vogue too long and the zamindari system which waxed strong in all its evil aspects is being abolished. But what should be the right course after zamindari is abolished? Peasant proprietorship offers no solution. Co-operative farming is a theoretical panacea, no doubt, but it is beset with practical difficulties. There is no homogeneity of population, literacy is inadequate, and above all the spirit of co-operation is lacking. Collective farming has in its favour the apparent success in Russia, one of the biggest countries of the world. Being in the grip of starvation we cannot afford to wallow in superficial sentiments of private property. To quote Lenin "only the material basis, technique, the employment of tractors and implements in agriculture can solve the problem in relation to the small farmer." In order to increase the per capita income of the farmer it is necessary to enlarge the size of the holding and increase the capita equipment per farm.

In agriculture the unhealthy effects of machine production are much less as compared to the use of power in industry. The agriculturist machine-worker escapes the automatising of human labour and the stunting of the physical and mental growth of the worker which are incumbent on industrial labour. The fact that agricultural machines are movable alters the relationship of the man to the machine. The worker directs the machine and is not its slave. Thus mechanisation of agriculture safeguards the welfare condition of labour at the same time relieving drudgery and monotony.

The success which has been attained through mechanisation in Western countries lends an increased impetus to India to follow up their success. In U.S.A. 500,000 farmers used to occupy sub-marginal lands till a new economic pattern of farming was introduced by the co-operative farms of

the Farm Security Administration. This adjusted farmers to the requirements of agricultural revolution without sacrifice of the economic democracy enjoyed by them. All low income farmers are educated and guided, helped to form a corporation and are given a loan for buying and developing their land in accordance with a plan drawn up by the F.S.A. engineers. The members are given a tangible stake in the enterprise to arouse their interest. The F.S.A. provides the operating capital for the purchase of machinery and other installations. The social effects of mechanisation do not operate on these farms. Such group farms warrant a place in tomorrow's agriculture. On the Western prairies of America mechanisation has reached fabulous proportions. Trains of huge farm machines clank across endless stretches of wheat. Similar methods are employed on huge open spaces in Argentina and the Ukraine. In England all major political parties are committed to an all out programme of agricultural expansion. No other nation protects its agriculture so thoroughly. In England the farmer can rely on two buffers: (i) the Government's price support programme which will fend off any farm disaster (ii) the reduction of costs through large scale mechanisation. Thus if India is to be self-supporting for her food grains and primary production she must resort to mechanisation.

Scope for Mechanisation in India

Mechanisation has to be pursued in accordance with local circumstances and what applies to foreign countries may or may not apply to ours. It is therefore necessary to ascertain to what extent mechanisation is possible in India. Here mechanisation can play a large role in—

(1) Bringing in more area under cultivation by reclamation of land.

(2) Eradicating weeds like Kanse and Hariali to increase the yield per acre.

(3) Prevention of soil erosion.

(4) Assisting the reduced number of draught animals in tilling and harvesting by means of improved implements.

Tractors are found useful in extending the area under cultivation by eradicating deep rooted weeds and shrubs and by contour bunding for the prevention of soil erosion. Tractors are also used for shallow cultivation when a large area has to be cultivated in the shortest possible time. Tractors provide the quickest means of harrowing, seeding, harvesting, and threshing. There are various kinds of tractors. For use in the smaller field the tricycle type "cub" tractor comes in handy. It has two driving wheels in the rear and a single wheel in front for steering. It mostly uses mounted implements making it particularly suitable for row crops for intercultivation and in small fields. Another type that could be easily used is the "garden tractor" which is light and two wheeled and has to be steered

by the cultivator walking behind it. The depth of ploughing in this case varies from 4 to 16 inches. The ploughs attached to these tractors are of two varieties—Mould-board ploughs which are preferred for moist soils and Disc ploughs which are useful in shallow as well as deep ploughing.

From the above description it can be seen how vastly different are the indegenous tillage implements exclusively used in this country. We have now to examine which of these modern equipments are adoptable to the widely differing soil and climatic conditions in India. Tractors of the wheeler and crawler type can only be used in fair sized fields. As the size of the tractor increases so must the size of the field to be economical. For wheat, jowar, bajra, barley and maize the basic operations of ploughing and harrowing by means of tractors would be profitable specially on dry soil. For cutting and ploughing in high stalks such as Cambodia cotton, the stalks of which grow to a height of 5 to 6 feet can be easily dealt with by tractors at a lower cost and speedier process than human labour. For wet land growing paddy no modern tractor will operate. Even for garden crops, both tuber and root crops, heavy tractors tend to pack the soil where thin loose soil is needed. Only light tractors of the "cub" or "garden" types could be used to advantage in garden cultivation.

The most useful purpose that tractors can serve in India is reclaiming millions of acres of uncultivated land. There are 170 million acres in India classified as cultivable waste. To reclaim this area, hilly land can be smoothened, depressions filled in, and crub trees removed with the use of tractors at a reasonable cost. Such operations are beyond the scope of the average cultivator. Agricultural land in India has another set back due to deep rooted weeds which infest the land and sap up the plant food from the soil. They present an insurmountable obstacle to human hand labour and animal power. The weeds most prevalent in India are Kans and Hariali. Kans is a kind of tall perennial grass with creeping roots while Hariali develops in black soil and has a mass of thick matted roots. All these weeds can be easily and quickly removed with tractors so that land which is now lying fallow can be brought under cultivation.

So much for tractors. Now there are other improved implements which are most suitable to Indian conditions and can be profitably used with little cost. It is here that rapid developments are necessary to obtain the maximum output with minimum effort on the part of the animal and the cultivator. The improved "Iron Plough" (mould-board and ridge) can now be tackled by draught cattle which have been freed from the toil of lifting water due to the introduction of well and canal irrigation and water pumps. On red loamy soil and on black cotton soil of a friable variety this improved plough brings in material advantage. The "Ridge Plough" is found useful in the cultivation of sugarcane and cotton as it forms ridges 2 ft. apart at all

the rate of two acres per day. If the ridging were to be done by hand it would involve thrice the cost. The "Seed Drill" (bullock driven) does the work of sowing in lines while dibbling takes more labour and time. On some of the larger farms, "Threshing and Winnowing Machines" can be used at half the cost and time required by hand labour and without waiting for weather conditions. "Chaff Cutters" can be used for cutting jowar stalks into standardised bits for feeding cattle. The "sugarcane crusher" with a 7 H.P. motor can crush half a ton per hour while the bullock driven roller mill crushes two tons per day of 12 hours. For contour and hillside work the "Two-way" Plough would be very useful. It turns every furrow uphill forming a miniature terrace to hold moisture and resist washing. When one plough is raised the other automatically locks into position. The latest invention in mechanised farming is the tractor "Altimeter." It is a guage which makes contour farming easier by showing when the tractor is travelling on level ground. It makes preliminary survey and staking unnecessary.

It is not so much the anxiety to save money as the urge to save time and utilise the moisture available during the short season that should impel mechanisation. The cultivator usually has to wait till the rains have fallen to moisten the soil before he can start ploughing; otherwise the soil is too hard for his ordinary country plough. Thus before he commences planting a lot of the monsoon passes away and his crop has to depend on a part of the short and irregular rainy season. Besides during this season labour is difficult to go even at higher wages for the essential operations. Mechanisation would enable the cultivator to start his planting with the first rain and bring in a more abundant harvest.

With the introduction of mechanisation serving and maintenance facilities for the tractors and implements become essential. Every collective farm in Russia has its own servicing station where the farmer can take his damaged machines for repairs or can call for repair aid from the station. Such repair stations are a necessary adjunct for mechanised agriculture. In the U.S.A. there are workshops attached to large mechanical farms where in addition to repairs, modern agricultural implements are manufactured for the farmers with small holdings. In India mechanisation cannot be made popular if proper workshop facilities are not provided. The Indian farmer is by nature conservative and is haunted by the fear that once the modern implements are out of working gear they have to be discarded and he would have to sustain a considerable loss of capital.

The Progress of Mechanisation in India

Since the last World War both Government and private enterprise have directed their efforts towards mechanising agriculture. The Central Agri-

cultural Department now have a Mechanical Cultivation Engineer. This Engineer is in charge of organising—

(i) deep ploughing of lands infested with Hariali and deep rooted weeds,

(ii) seasonal ploughing with tractors to increase the food production specially in areas where there is a shortage of draught cattle,

(iii) land development and improvement.

In India the whole agricultural problem is intensified by the fact that the initiative has to be taken by the Government. The Central Agricultural Department has set up over 400 agricultural stations in addition to Pusa under the immediate supervision of government officers. They conduct research, demonstrations and the distribution and sale of seeds and implements. Such demonstrations are also carried on by itinerant officials on the farmer's own land and implements are made available in this way. Government has now opened a Central Workshop at Izatnagar for the production of tractors and agricultural implements in order to make them available to the cultivators at moderate prices. Such workshops as the one opened at Izatnagar are a great necessity now in view of the drive to bring all virgin and waste lands under cultivation. A further impetus to mechanisation was received when the Ooty session of the E.C.A.F.E. arranged for the production and distribution of agricultural requisites for Asia and the Far East. Since the establishment of a national government improvements in agricultural methods are being speeded up. This is proved by the fact that the Central Council of Agricultural Research under one of their schemes is determining the possibility of using aerial photography for estimation of crop areas.

The Provinces in India had not so far made any considerable contribution to the economic development of agriculture because their independent heads of revenue undr the British Raj were never sufficient to finance any large scale expansion. The various funds accumulated from the revenue surpluses of war years have provided the impetus to Provincial Ministries and the Bombay Government's 80 crore plan is spectacular. There are already 214 Demonstration Centres in the various talukas of Bombay province and according to the plan 500 additional centres are to be provided. At each of these a trained kamgar is stationed to guide the cultivator in improved methods and each centre has its seed and implement depot. The produce of such land remains the property of the owner. Power machines such as pumps, engines, chaff-cutters are in use in Ahmednagar, Surat, Nasik and Belgaum.

In Coimbatore and Travancore state mechanisation has been used successfully and comparatively stony land has been brought under garden cultivation. Cultivated dry land in these areas is being improved gradually

and crops like ragi, tobacco, turmeric and onions are grown on these reclaimed lands. Labour is required all through the 12 months in garden land cultivation as it admits a great diversity of cropping.

Early in September the Agricultural Ministers met in a conference in Delhi where certain targets for food production were set. But not more than 50 per cent of these have been achieved. This is due to the absence of a central plan of economic development which has created an atmosphere of tentativeness. Pursuant to the recommendations of the Agricultural Ministers' conference a party of experts are touring the states to fix new targets for increased food production. Importance is being attached to indegenous resources of iron, steel, and coal for making agricultural implements available. In view of this, financial assistance from the Centre must be primarily restricted to this scheme. Government must undertake to finance immediately productive schemes and the disinflationary policy formulated should not slow down the progress of such schemes.

Progress of Mechanisation in Hyderabad

In Hyderabad State substantial development in mechanising agriculture has taken place in recent years, as a result of the active participation of the State government. The Department of Agriculture has 17 tractors of 60 to 100 H.P., one motorized Grader and two motorized Terracers. Nine more tractors of 70 H.P. each have been ordered out and are expected shortly. These tractors are equipped with furrow mould board ploughs, disc ploughs, disc harrows and subsoilers. These departmental tractors are made available for cultivating lands under certain conditions. Cultivators of Diwani area pay at the rate of Rs. 20 per acre, a flat rate which includes operating cost, transport charges, repair, maintenance, and supervision. From cultivators of non-diwani areas Rs. 27 per acre is the amount charged. The Agricultural Department have a scheme under which more area is to be brought under cultivation by eradicating deep rooted weeds, developing virgin lands and making contour bunds for prevention of soil erosion. Annual ploughing and other tillage operations are not undertaken under this scheme. In Nizamsagar, agricultural facilities have been rapidly speeded up and under the above mentioned scheme 2 lakhs 75 thousand acres of cultivable waste are to be brought under the plough. Nizamsagar has been the main area for food crops as it produces 40,000 tons of food grains per year. If the above scheme for reclaiming land in Nizamsagar is put through, together with intensive farming, Hyderabad would be able to export food grains to scarcity areas in India. The Agricultural Department also gives assistance to the cultivators by supplying engines for pumping water. Oil engine pumping sets of horse power ranging from 5 to 20 are supplied to the cultivators on Taccavi loans which are repayable in 3 years. Well boring facilities are also provided on the cultivator's land. Bore holes by power driven well boring

machines are made in the open drug wells of the cultivators for increasing the water supply or for restoring lost supply. Tube wells are also constructed for the cultivators. All such well boring is also carried out on Taccavi and one-fourth of the total cost is given as subsidy if the bore well is used for growing food crops. Only ploughing on a small scale is carried out by wheeled tractors in Government forms in Himayatsagar, Warangal and Parabhani. It has been found that the effect of tractor ploughing on yield is indirect. On black cotton soil due to effective eradiction of weeds and better turnover of soil the yield per acre increases by about 10 per cent. Wheat being a dry crop grows best on deep black soil along the Godaveri river and on silts. Wheat therefore offers much scope for tractor ploughing specially because it can be rotated with garden crops. Paddy cultivation could be greatly assisted if the Agricultural Department had more motorized Terracers. For successful rice cultivation a good and constant supply of water can be best secured by having level plots with proper embankments. These Terracers would be very useful in the processes of levelling and terracing which would prevent scouring and the plot could hold water evenly all over the field.

There are about 10 to 15 big landlords in the state who own tractors. They are mostly in Warangal and Nalgonda districts. They purchased tractors about a couple of years ago. Unfortunately most of the equipment of these tractors has been damaged in recent communist activities. The Bodhan Sugar Factory owns its own tractors and mechanised methods of ploughing, harvesting and binding are followed on these sugarcane farms. In the State as a whole the sugarcane produce is not as high as in Java where the yield per acre is 40 tons as compared with 10 tons in Hyderabad.

Through state aid several co-operative societies and co-operative banks have been established to aid the small farmers for the purchase of land, seed and implements. The farmers who organise themselves into credit societies are given loans on the mortgage of their lands. At the end of 1947 there were 4,077 credit societies and the co-operative banks had loaned them nearly 8 lakhs of rupees. In addition to these there are three Implelments Societies with a working capital of two lakhs. These sell and rent agricultural implements, mostly iron ploughs, chaff-cutters etc., to the farmers.

The same problem presents itself in Hyderabad as it does in India viz., that of the sub-marginal cultivator. There is an overwhelming majority of small land holders and it is of prime importance that their holdings should be enlarged in order that mechanisation may be economic. This can be done through the Agricultural Co-operative Societies and through state aid. The monthly expenditure of the state government on agriculture is 3 lakhs 25 thousand rupees excluding irrigation expenditure and the acreage under cultivation is 23 crores. The total produce in the state is only 2.6 million

tons of food grains per year which is insufficient for the requirements even of the local populations, which shows that for the yield to be increased of raw products and food grains the government must extend its expenditure to cover the introduction of new modes of farming specially of the intensive type. As Prof. Iyengar aptly puts it "to balance the State Budget is not so important as providing adequate capital finances to the artisan and the cultivator."

In Hyderabad the average cost of implements is only 6 per cent of the total cost of production which is very low. The only implement commonly used here is the seed drill. The table land contour of the country makes it eminently suitable for tractor cultivation while those areas which are craggy can be used for garden cultivation. Jowar is of course the main dry crop of the state; ploughing and harrowing by tractors would reduce its cost of production and increase the yield. Chaff-cutters are used on a few farms for cutting the jowar stalks into standardised bits for cattle fodder. Rabi jowar is usually sown with a drill but the cost of reaping, threshing and winnowing is high. It takes 10 women to cut an acre of jowar per day and 10 labourers are required for threshing and winnowing per acre. If threshing and winnowing machines could be introduced they would perform the same process at half the cost and time required by human hand labour. The groundnut too is extensively grown as a dry crop and does not need very rich soil or much water. Small garden tractors could pulverise the soil and do the hoeing after which the nut could be sown. The groundnut has become a very paying cash crop and it is found in Himayatsagar Farm that the Big Japan variety of groundnut yields 50 per cent oil from its kernel and the cake forms good fodder for milk cattle and bullocks. The yield per acre here is only 200 lbs. and much of the crop is spoiled by improper decortication. In South America special machines are used for removing the shells without damaging the nuts which get rancid very soon if broken. Ground nut crop also gets infested with weeds which could be removed with light tractors so that the yield per acre may be increased. Castor is also suited for garden cultivation just like *til* and mustard. All along from Secunderabad to Bezwada is stony country full of granite boulders and in open spaces between these boulders and among slopes flanking valleys castor is grown. Much of the seed is lost in harvesting and in threshing which is done by beating with a stick. It also entails considerable loss of labour and time. Both these operations could be carried out at a lower cost by machines and the out-turn of seed could be increased which is as low as 300 lbs. per acre. In C. P. and Berar the average yield is 500 lbs. per acre. Cotton is another dry crop which offers much scope for mechanisation. The State has nearly 37 lakhs acres under cotton cultivation and forms the chief cash crop of the farmer. The usual practice is sowing with a wooden drill and harrowing with a blade harrow. These methods are comparatively primitive consider-

ing that the Ridge Plough could form ridges as it ploughs each ridge 2 ft. away from the next at the rate of 2 acres per day and this is an essential operation in cotton cultivation.

Thus what holds good for the rest of India holds good for Hyderabad also, that natural potentialities could be developed with advantage by applying modern methods of cultivation.

Cost Factor in Mechanisation: One of the chief factors that decides whether or not mechanisation will yield fruitful results is the relative cost of work. It has been universally recognised that one of the methods of reducing unit costs is to enlarge the size of the farm and go in for more intensive farming. Extensive farming is not the usual practice in India. The problem here is one of raising the lower limit of farms to an economic level. It is a problem of bringing more lands under the plough and the redistribution of land on the basis of an economic farm size. It is in this context that the optimum size of farms in different regions acquires a new meaning. Co-operative societies could do much in this connection so that individual resources could be pooled for common benefit. The government also can help by resorting to a scheme of collective farms. Mechanisation can be economical only if the machinery is used throughout the year for the various agricultural operations. It is for this reason that state aid is so essential for mechanisation in India. The Government should advance loans to a group of neighbouring cultivators for the purchase of machinery which could be used on their farms. These advances could be recovered in easy annual instalments. Ultimately Government can buy tractors and implements and loan them out to the cultlivators on the hire purchase system. For example the Indian Co-operative Union has sponsored several refugee families to cultivate 400 acres of land in Chitarpur village near Delhi. These people are receiving aid from the Ministry of Agriculture in the form of tractors, technical personnel, implements and seeds. This should afford a guide to similar activity elsewhere in the country.

Before the last war when conditions of living in India were comparatively cheap and labour was in plenty mechanisation costs were found to be heavy and its prospects for application throughout the country seemed remote. But since the war conditions have changed vastly. There has been a phenominal rise in the cost of living index and labour has become expensive and scarce due to rapid industrialisation. Therefore mechanisation offers an economic proposition as compared to the cost of man and animal power. It is found that costs of production and yields (including prices also) can be adjusted properly if mechanisation is resorted to. The following table shows that the cost of work and the capital outlay for power farming as compared to animal power is much less.

(The figures are as given by Mr. Subba Rajoo, Department of Agriculture, Hyderabad)

Cost of Tractor Farming with one 40 H.P. Tractor.		Cost of bullock farming with 40 pairs of bullocks to equal 40 H.P.	
	Rs.		Rs.
Purchase price of tractor & implements ..	25,000	Purchase price of bullocks at Rs. 400 each ..	32,000
Annual depriciation ..	5,000	Annual depreciation ..	3,000
Running expenses per hour		Cattle fodder at Rs. 40|- per month per pair for 40 pairs per year ..	19,200
Fuel & lubrication 6-0-0 Per year of 20,000 hours. ..	12,000	Cost of labour 40 men for 8 months at Rs. 25|- per month 10 men for the whole year ..	11,000
Cost of labour One driver at Rs. 90|- Two mechanics at Rs. 60|- each per month ..	2,520		
Annual repairs ..	2,000		
Total cost	21,520	Total cost per year	33,200

Thus we find that the operating cost as well as the cost of capital outlay is less in power farming. With the use of power alcohol the cost of fuel should be further reduced. At the Government experimental stations it has been proved that the yield per acre has in mechanised farming been raised by 40 per cent and often more. Thus if costs are lower and yield per acre is greater it stands to reason that mechanisation is more economical than the prevailing system of cultivation in India.

India is still going through an orgie of unprecedented inflation. It therefore becomes all the more necessary to aim at full employment and reduce the costs of production which as seen above can be attained through mechanisation. Besides Government has declared that its deflationary policy will not affect immediately productive schemes. What could be more immediately productive than an improved mode of agriculture? It is bound to yield a large produce at every harvest specially of food grains. In this connection Mr. G. D. Birla's Pocket Plan is valuable and it estimates an expenditure of 357 crores.

The value of Propaganda and Technical Education for mechanisation cannot be over estimated. There still remains a great gap to be bridged between scientific achievements and their introduction on the fields of the Indian cultivators. To realise this a scheme for propaganda and demonstration must be put into effect similar to the one visualised in the Bombay Government Plan. Except for the experimental stations and the publication

of leaflets there has been no properly organised effort to develop publicity to cover the gulf between research stations and actual village fields. Government should set up a separate mechanism for publicity to popularise mechanisation and dispel fear and suspicion for machinery from the minds of the local farmer. In India such publicity should be carried out in various regional languages in the form of books, talks in the villages and by broadcasting radio programmes for rural areas and arranging for their reception. Short instructive films and cinema vans would not be out of place where fairs and religious *jatras* are held. Exhibitions of modern farming equipments could be held from time to time.

Another bottleneck which mechanisation in India is beset with is the lack of technical personnel for maintenance and repair. During the last War many unskilled men have been trained as lorry and tank drivers, fitters and mechanics. These men have been demobbed and would be very useful in handling farm machinery. Government can face the shortage of technicians by opening up technical training centres in different parts of the country. The Board of Agriculture in 1945 recommended the provision of facilities for repair and servicing at Government agricultural workshops and for the holding of stocks of spare parts for tractors and implements. These recommendations have not yet been implemented but if done so would push mechanisation forward.

Soil Impoverishment: It is often argued that intensive cultivation which mechanisation entails tends to impoverish the soil specially in an old country like India where farming has been going on from times immemorial. This argument can be refuted by the theory that even without the application of manures, yield per acre has increased, because land has its own recuperative faculty and experiments at Rothamstead have proved this. The life of the soil is in no way affected by mechanisation provided the correct type of implements are selected to suit the soil under cultivation. For example mould board ploughs should be used for ploughing heavy soils while disc ploughs should be used for sandy and gravely soils. In very hard land formations subsoilers are used to break up the lower layers without bringing them to the surface. The U.S.A. has long been leading the world in methods of soil conservation which have contributed to the highest agricultural production in the world. In addition to this, the use of light alloys for the manufacture of ploughs is under consideration. When such ploughs are put on the field it is estimated that they will be lighter than the iron plough and more effective than the wooden one, giving longer life to the soil as well as securing proper turn over. The soil resistance and the depth to which the implement should penetrate should decide the type of implement required.

Conclusion: No one can deny that India has to remain mainly an agricultural country even after her ambitious schemes of industrialisation have

materialised. Thus to reorganise agriculture and to place it on a more economic footing the targets to be aimed at are an increase in net returns, a reduction in production costs and a saving of labour and time. We have seen above that all these economies are effected through mechanisation and without any of the social evils connected with industrialisation. It is therefore in the interest of the country to consolidate her newly-won freedom by strengthening her agricultural economy and tiding over her food crisis by revolutionising the technique of cultivation.

MECHANISATION OF AGRICULTURE WITH SPECIAL REFERENCE TO CULTIVATION OF WASTE LANDS

by

DR. V. V. SAYANNA

"Only listen and understand the talk of the machines,
You, the future Master, you, the Messiah!
With steam, steel and fire, you are allied!
You will capture the globe." Sadoviev, At the Lathe.

Introduction :

Progress of humanity, in the material sense, has been marked by the measure of man's control and mastery over the powers of Nature and the use of its resources through mechanical appliances. Mechanisation in agriculture is only partly symbolic of that continuous process of man's conquest over Nature. It chiefly consists either to replace or assist, or both, animal and human labour in farming by mechanical power, wherever possible. Application of machine methods to agriculture has made rapid advance particularly in countries like the U.S.A., the U.S.S.R. Canada and Australia and some other countries of Europe. Tractor ploughing has dispensed with the wooden ploughs of yore and the need for draught animals for cultivation of land. The combine-drill performs both sets of operations of sowing the seeds and putting the fertiliser simultaneously, while the combined harvester-thresher has simplified the work of reaping and threshing into a joint process and rendered obsolete the use of the sickle, the pitchfork and the scoopshovel. Plant setting, vegetable and small fruit production, hedge demolition and drainage operations, tractor-spraying of the insecticide, cotton picking and even some of the household work of the farmer's families have been increasingly mechanised. The lorries and the railways, the system of elevators and conveyors, have come into general use for transport, marketing and storage of farm products and livestock. Thus

in modern agriculture, the farmer is employing machinery in one way or the other in almost all farming operations ranging from breaking up the soil to marketing and sale of the produce of his farm. This is made possible largely owing to extension of electricity to the country side, manufacture of agricultural machinery suitable to farms in varying climatic and geographical circumstances and dispersion of instruction in technical and rural engineering at the agricultural schools.

Progress of Mechanisation in different Countries :

Where the units of cultivation are large, where difficulties exist regarding employment of work animals or manual labour on account of their scarce supply or high costs of employment, and where there is specialisation in the crops grown, without any hindrances such as conditions of land tenure, topography, climate, system of cropping etc. mechanisation in agriculture has progressed far and wide. But at the other end in countries like China, India and broadly in the greater part of Asia and Africa the response to mechanisation even at present is found very limited due to a variety of factors as the abundant supply of man and animal power available as well as the appalling poverty and general backwardness of the peasantry. The proportion of human to other forms of power (mechanical etc.) to the average worker in all industries estimated in some countries was 5 : 1 in China, 1 : 2 in Japan as compared with the ratio of 1 : 9 in France, 1 : 14 in Germany, 1 : 23 in the U.K. and 1 : 35 in the U.S.A.[1] In the wheat belt of the U.S.A. almost every farm has one tractor at least and there are more than one in many cases. In France and Denmark too, farms are well-equipped with agricultural machinery and in fact the harvest-binders and reapers are in common use all over, even in small farms. The value of mechanical equipment of farms in the U.S.A. increased by about 2½ times during 1910 and 1930, the value in 1930 being estimated as 3,301.65 million dollars.

The U.S.S.R. is known as the country where machine methods in agriculture are introduced and popularised on an unprecedented scale and rapidity during the two decades[2] following the Revolution. With the success of the collective farms, the number of the State Machine Tractor Stations almost doubled, the number of tractors commanded by them rose to three times and the combines about ten times during 1934 and 1939. Between 1936 and 1939 the number of threshing machines increased by 1½ times, motors 2½, and lorries and cars 5½ times. A large portion of the sowing, threshing and harvesting on the collective farms is carried on by machines supplied

1. Vide, Modern Agriculture by W. E. Grimes and E. L. Holton, Boston, 1940 Ch. XXIII p. 543.

2. See, Year Book of Agricultural Cooperation, Cambridge, 1942 pp. 197-205. Note : In 1939 there were on the collective farms, 66, 476 machine tractor stations employing 394,000 tractors and 127,000 harvester combines. Besides, in the same year there were 5,008,400 ploughs, 708,500 sowing machines, 2,98,000 threshing machines, 90,700 lorries, 48,300 motor cars and 1,247,000 motoring machines & reapers. *Ibid.*

by these State Machine Tractor Stations, the remuneration to the work in kind being estimated at 20% of the total costs of the collective farms. The volume of work done by the Stations for the collective farms during the years 1934 and 1939 was as follows:—

In million hectares.

	1934	1939
Total area ploughed	12.2	22.7
„ „ sown: (a) Spring Crop	6.4	40.2
(b) Winter Crop	4.3	16.4
„ „ harvested total (Grain)	11.4	44.2
Proportion of above harvested and threshed by combines	1.6	41.0

Rural electrification and mechanisation :

Extension of electricity to rural areas in recent years has facilitated the application of machinery to farms more cheaply and more often. Electricity is utilised for the working of such machines as feed grinders, ensilage cutters, seed-cleaning machinery and milking machines and also to furnish lights and power in the farm households and in farm buildings. Rural electrification has made large strides especially in the densely populated regions, and the difficulties encountered due to high costs of installation and transmission in case of low density areas are to some extent overcome by means of state subsidies and development of the co-operative effort of the people concerned. In fact in many parts of Europe mechanisation in farming has been inseparably associated with electrification of the countryside. Under the R.E.A. (Rural Electrification Administration) electrical service on co-operative lines has expanded reasonably in rural areas[1] in the U.S.A. While only 1|10 of farmers were benefited by electrical service in 1935 when the R.E.A. was established, today one farm in every four is electrically equipped with the result that the total number of the R.E.A. sponsored Co-operatives for electrical service grew to 617 by the end of June 1940. These co-operatives have not only proved that electricity can be supplied at reasonable costs in rural areas but also have served to whip up the private utilities in the regions to cater their service on a comparative basis at moderate rates. Doubtless, where electricity can be generated cheaply, adoption of agricultural machinery run by electrical power will

1. According to the latest Administration Report of the Madras Govt. (Electricity) a good number of development schemes for the generation and supply of electricity to both urban and rural areas estimated at Rs. 9 crores were sanctioned. The biggest amongst them is the Mach Kund hydro-electric scheme, a joint undertaking of the Madras and Orissa Govts. All these schemes have to be carried out in a period of 5 to 10 years. Apart from the Tungabhadra project in this province, similar projects of a bigger or smaller magnitude are planned or launched by the Central and other Provincial Governments in co-ordination e. g. the Damodar and the Kosi river projects involve, among other things, generation and supply of electricity to different areas.

go a long way to bring down production costs and with them the prices of agricultural commodities to the consumers.

Advantages and limitations of Mechanisation :

Mechanisation of farming reduces much of the drudgery of manual labour in certain operations in agriculture, enables the farmer to be more efficient, to produce more, to secure higher incomes and to live a better kind of life on the farm with more leisure. With the expanded use of machinery there will be a contraction in the demand for work animals for ploughing, water-lift, harvesting, transport etc. and a reduction in the need for employment of human labour particularly the labour of women and children. The economies of mechanisation in terms of men, material and time as well as in terms of efficiency and quality of the work done are too obvious. For instance, in actual operation, costs amount to little when idle, whereas the cost of maintenance of draught animals remains more or less the same during both periods of working and idleness, because the animals have to be fed and attended to whether they are doing work or not. It is therefore advantageous to use tractors when a great deal of work has to be done in a short time or in highly specialised forms of agriculture characterised by comparatively short periods of work at high pressure accompanied by long periods of inactivity. On the other hand, employment of animals works out more economical when the work is spread over evenly over the entire year.[1] The ultimate effect of all these advantages is to bridge the gap between the standards of living in the urban and the rural areas and to establish a degree of equality of labour conditions in the country and town. Some of the limitations for expansion of mechanisation are already indicated. It may be noted that extensive use of machinery, although resulted in displacement of animal labour, could not, in all the countries referred to, succeed to the same extent with regard to human labour, perhaps owing to the complicated movements involved and other limitations where hand methods are preferable to machine methods. In this light there is no fear of large scale unemployment of labourers consequent on competition of machines with men. But rather, machinery has served as a powerful auxiliary for the labourers to work more effectively and with less physical strain.

Some other considerations :

Before this section concerning economics of mechanisation of agriculture is closed two more aspects of the question viz. (a) mechanisation in relation to small holdings and (b) mechanisation in relation to employment of labour and wages may be briefly laid down.

1. League of Nations' publication No. 7, pp. 19-20 (European Conference on Rural life 1939).

(a) *Small holdings vs. application of machinery :*

The question of application of machinery to small farms implies consideration of many aspects, technical, economic and some social. It may be pointed out here that the issue of securing to the small farms some of the benefits of mechanisation should not be confused or identified with the old controversies of advantages and disadvantages of small vs. big holdings or small scale vs. large scale farming. Each has got its own place in agriculture and each has its merits in respective conditions. Since the great depression, the creation and encouragement of family-sized farms has been the feature of the land policies in most countries of Western Europe [2] and in the U.S.A. The expediency of establishment of family-farms in hoary and densely peopled countries like India, China and Japan (cf. the favourable factors for creation of large holdings in new and undeveloped countries as Australia, the U.S.A. or under the highly socialist economy of the U.S.S.R.) has been unequivocally recognised by agricultural economists long back. In fact, the size of the holding assumes significance for us with reference to the type of farming adopted e.g. individual, joint or co-operative systems. Though mechanisation appears best suited to large farms, of late there has been a movement for extending such benefits to small and medium-sized farms in various ways. In the first place, the general tendency among manufacturers of agricultural machinery is to turn out machines, suitable to the technical and economic needs of small holdings, possessing at the same time the advantages of large machines. Researches are to be directed for construction of a type of multi-purpose tractors at moderate prices which can cater to as many requirements of agriculturists as possible and which can be easily shifted on from one operation to another as they are completed. Secondly, establishments of co-operatives among small farmers for purchase and use of machinery in common is encouraged both by private and state initiative. There were about 30,000 agricultural syndicates or general agricultural co-operative societies in Europe at the end of 1938 for this purpose. In addition to these, special co-operatives are also found to fulfil the same needs e.g. there were 283 co-operatives in Estonia and 400 in Finland for

2. A study of the composition of farms according to various size-groups in the countries of Western Europe during 1929-33 shows that the size groups of 2 to 5 and 5 to 20 hectares occupy considerable portion both in number and area of farms. In Germany, 34.4% of farms in the Reich consisted of 5 to 20 hectares. The corresponding statistics for some other countries are 33% in number as well as in area in France, 38.6% and 56% in Ireland, 26% and 44.4% in Netherlands, 36.3% and 56.6% in Switzerland, 34.2% and 88.5% in Denmark, and 32.2% and 41% in Sweden. If the two size groups of 2 to 5 hectares and 5 to 20 hectares are taken together they represent 24.7% of the number and 66.6% of the area of farms in Belgium, about 33% in both number and area in Italy, 42.7% and 74% respectively in Norway. *Vide* The International Review of Agriculture, March 1943, p. 81 E.

Note :—The first noticeable fact is that in spite of the predominance of small holdings, considerable headway has been made in all these countries with regard to technical progress in farming. This, indeed, is a sufficient answer to those that are sceptical about the scope and success, of application of agricultural machinery in India.

the use of machinery, 670 threshing co-operatives in France and 800 in Germany, 286 co-operatives for machinery in Latvia, 133 in Lithuania, 460 in Switzerland and 64 in Yugoslavia.[1] Thirdly, the State has a recognised role in the matter either by way of giving subsidies or by provision of loans at concessional rates, regulation on manufacture and import of agricultural machinery with a view to meet the requirements of the small farmers. The Ministry of Agriculture in Hungary bears 33 1|3% cost of animal drawn machines and 66 2|3% cost of mechanical equipment operated by hand. To ensure satisfactory quality of the machines, a law was enacted in Latvia for the inspection of agricultural machines manufactured or imported. State aid was also given for establishment of machine depots for manufacture of machines suitable for small farms or of specified types. To illustrate the extent of mechanisation of small farms, it may be mentioned that according to the investigations made in Denmark in the year 1932-33, on farms with an area under 10 hectares there were machines, instruments and other implements valued at 235 crowns per hectare; on farms between 10 to 20 hectares 193 crowns per hectare; between 20 and 30 hectares 152 crowns; and on farms between 30 and 50 hectares 128 crowns per hectare; and broadly on large farms the value of implements was assessed at 112 crowns per hectare. On the islands 35% of holdings of less than 5 hectares were noticed using sowing machines; roughly 40% of farms with an area of 5 to 10 hectares used reapers; threshers were used on 70% of holdings between 5 and 10 hectares; 30% of small holdings between 1.7 and 3.3 hectares had threshers.[1] This widespread use of machinery in Denmark in relation to the cultivated area is attributed to the existence of small and medium-sized farms.

(b) *Mechanisation vs. agricultural labour and wages:*

Pessimists frown at extensive use of mechanical power in agriculture as they fear that it may lead to colossal unemployment in rural areas and a decline in the wage-rates. Such were indeed the predictions made by some prophets at the beginning of the Industrial Revolution and the introduction of the spinning wheel, the automobile and the steamer not to mention the invention of the rifle and the gun-powder! In fact, there are not a few who hold even now that introduction of machinery is one of the major causes of all recent troubles of over-production, or strained relations between employers and labourers in agriculture and elsewhere. Making allowance for personal prejudices, it only indicates the failure of such individuals for grasping and analysing properly the nature of the problems and their causes. Quite the contrary, the adoption of machinery for agri-

1. Vide L Action co-operative en milieu rural. Study prepared by the Co-operative service of the International Review of Agriculture, Vol. XXXIV, No. 3, P. 108E.

1. Vide Denmark, L'Agriculture, Le Conseil dell, Agriculture Copenhegen, 1935, Quoted *Ibid*, P. 199E. (1 hectare=2·4 acres).

culture has made good for the loss of labour absorbed by industries and towns and the flight from land faced hitherto in some countries. Introduction of machinery has enabled the worker to produce many times more than what he can otherwise do by hands. According to estimates made in the U.S.S.R. an individual farm required 20.8 days of a man's work to produce one hectre of grain in 1922-25 and a collective farm 10.5 days in 1937. Similarly, while an individual farm required 3.2 days in 1922-25 of a man's work for producing 110 lbs of grain, only one day was needed by a mechanised collective farm to do the job in 1937. It is evident that as a result of mechanisation the productivity increased approximately threefold in these cases. As for wages, it is a matter of common knowledge that in the face of motorisation of agriculture, the wages of labour have registered a rapid rise and continue to do so leading to a rise in the general standards of living of the labourers during the last half a century. In fact the low wages and low living standards in the countries of the East and the middle-East are ascribed to the inefficient methods of farming and for want of technical progress made in agriculture.

II

Scope for mechanisation of agriculture in India

It is often contended—in fact, many times taken for granted—that although all that is said about mechanisation in the preceding section may be alright with reference to other countries, it is definitely impracticable, unsuited and still more, harmful to Indian conditions of agriculture. Therefore, an attempt is made in this section to examine the scope for mechanisation of agriculture in India under some of the following headings in their baldest form viz. factors favourable and unfavourable, attempts for introduction of machinery and the government policy, and lastly mechanisation vs. the "Grow More Food Campaign" and cultivation of waste lands, while in conclusion some of the main recommendations are summed up.

1. Factors favourable and unfavourable:

The small size of holdings, the high demographic pressure on land and the prevalent mass of rural proletariat, the huge number of bovine population and their small size, innumerable tenurial patterns and insecurity of tenancy, subsistence cultivation without sufficient economic outlook, methods of cropping and lack of specialisation, frequent failures of crops due to vagaries of climate and rainfall, the illiteracy and poverty of the peasantry—these are some of the chief factors that set the limits, (though not insurmountable), within which mechanisation has to make headway in Indian agriculture. At the other end, the low productivity of agricultural land, existence of vast tracts in different parts of the country lying waste, fallow or unreclaimed which have to be soon effectively brought under the plough,

favour the adoption of machinery. The delicate food situation in the country, the colossal flight of people from the areas affected by partition such as East Punjab create the urgent need of application of mechanical power at least for some time to come.

Statistics concerning the size of holdings, the number of bovine population, and the extent of utilisation of hydro-electric resources in some countries are given below:—

i.	Average size of holding :	U.S.A.....145 acres		Germany..21.5 acres	
		Denmark .... 40 „		England .. 20 „	
		Sweden .. 25 „		India* .. 5 „	
ii.	Density of cattle per 100 acres of area sown :	India 67 ; Egypt 25 ;		China 15 ; Japan 6	
iii.	Proportion of† utilisation of hydro-electric power to total available estimated resources.	Switzerland	..about $\frac{3}{4}$	France	..about $\frac{1}{3}$
		Germany	..Over $\frac{1}{2}$	Japan	.. „ $\frac{1}{2}$
		U.S.A.	..about $\frac{1}{3}$	India	..less than $\frac{1}{50}$

Attempts for introduction of machinery and the Government Policy:

In spite of the radical changes that are taking place in the working methods in agriculture in many parts of the world during the last 30 or 40 years, the Indian peasant appears to remain much the same unchanged in sticking to his wooden plough, sickle and other simple and time-honoured implements for which we should not blame him entirely. It is true that certain types of machinery and improved implements like sugar-cane crushers, water-lifts and pumping machinery, fodder cutters, iron ploughs etc. are found in common use with the big landlords. However, it must be admitted that still the people at large are not become mechanically-minded.

Mechanical traction is experimented by a handful of big land owners, zamindars, or private bodies in parts of Gujarat, Karnatak, the C.P., Upper Sind, north Bihar and Orissa. But it may be mentioned that broadly speaking upto the outbreak of World War II, there was no planned or definite effort by the private bodies or individuals or on the part of the provincial and central governments to encourage the use of machinery except the little departmental success achieved by the Departments of Agriculture in some localities. The latest movement towards large scale use of agricultural machinery is largely the bye-product of the "Grow More Food" Campaign. It has received further impetus from the problems cropped

* The average size of holdings in various Provinces in India ranges between 2 to 11.7 acres according to the available data in 1931.

† The potentialities of India's hydro-power resources rank only next to Canada and the U. S. A. but only $\frac{1}{2}$ million kilowatts have been exploited so far out of the estimated total of 27 m. kilowatts.

Note : Some of the statistics given above are taken from the " Indian Rural Problem," as quoted from different sources therein.

up recently after the war and the Radcliffe-award concerning rehabilitation of the ex-service men and the refugees.

Mechanisation of agriculture is taking place to an appreciable extent in various parts of the country in recent months. 300 tractors were received from abroad and distributed during January-April 1948 to the Provinces and States; 200 more tractors are expected arrival from the U.S.A. and the U.K. Besides, the Government of India have obtained after the war about 300 tractors from the U.S. Surplus Stores, a good number of them having been disbursed to the scarcity provinces and states. A stimulated demand form the provinces and the Unions of States for the agricultural machinery is noticeable as a result of the successful operation of schemes of reclamation of waste lands carried on by tractors supplied by the Central Tractor Organisation of the Ministry of Food and Agriculture. The Madhya Bharat Union has asked for three units of 15 tractors each, the C. P. and Berar for six units while the Government of U. P. propose to carry out the schemes in Ganga Khadar, Naini Tal Tarai and Jhansi on which 45 tractors are engaged in work. However, there is nothing surprising in these demands when we consider that India purchases less than a thousand tractors a year, while every individual factory in America annually produces perhaps more than a million. Intensive research work on the design and more economic manufacture of improved agricultural implements and investigation into the possibility of more effective use of mechanical appliances in increasing food production and saving time and labour costs is proposed to be undertaken by some of the workshops and manufacturers in the Bombay Province. The Prime Minister of India, recently launching the first Indian built Diesel tractor at the Sion factory (Bombay)—belonging to the manufacturers of tractor-drawn heavy implements for the Government's "Grow More Food" drive—commended that "the development of tractor ploughing is very important for our country, and every such development should be encouraged," though the occasion may only go to lay dowr rather "the beginnings of mechanical agriculture."

The points that are to be borne in mind for designing suitable machinery for conditions of Indian agriculture may be outlined as follows: Since ploughing in India has largely to be done in dry summer months of April and May in hard-set soils, the two-plough tractor must have a little more horse power say minimum 30 H.P. fitted with electric lights so that work may be done in the cooler hours of night avoiding the scorching heat of the midday sun. The next question is concerning fuel; it must be as cheap as possible and in this respect diesel-tractors are preferred to machines run by petrol. Besides, it must be the farmer's over-all power plant doing his ploughing, seeding, little or pumping water and also working as an automobile with rubber wheels, with field speeds of 3 and 4 miles per hour and

road speed of 10 to 15 miles per hour, so that the machine can be used for transporting manure to the fields, and marketing the farm produce to the nearby markets. Further, the size of machinery, provisions for repair housing and above all, credit for purchase or hiring of the machines are equally important aspects.

Mechanisation vs. the Grow More Food programme and reclamation of waste lands: [1]

On the recommendation of the Food Grains Policy Committee, extensive experience are being carried on for reclamation of culturable waste-land particularly in the provinces of the U.P. the C.P., the Punjab, Bombay and Madras. A brief account of the progress of work in some of the provinces is given below. The first experiment was carried on in the U.P. where over 45,000 acres of waste-land were reclaimed in the last season with the help of 200 tractors which the Government obtained from the U.S. Army equipment, the area reclaimed during December and May 1947 being about 26,000 acres. In the C.P. about 150,000 acres of land are laying waste in Sagour district infested with 'Kans' which takes deep root in the soil and cannot be removed by the ordinary plough. The Provincial Government have planned to clear this area of the pest 100,000 acres at least and bring it under wheat cultivation. Thirty two tractors have been working in the village of Khurai and ploughed nearly 7,000 acres of 'Kans' ridden tract during March and June 1948 when the outbreak of the monsoon withheld their operation. Tractor cultivation is already begun in Hoshangabad district and it is hoped to start work in the other two centres of Nagpur and Daryapur (Berar) about middle of April. The Government propose to secure more units of tractors and reclaim the whole tract by stages. The Minister for Agriculture of the Central Government after touring the areas in the middle of the year promised to put 6 more units of 15 tractors each under the disposal of Provincial Government to bring in more land under wheat cultivation. The owners of some of these lands have enthusiastically welcomed the scheme and co-operated in the land consolidation process. Bunding is being done with the help of bull-dozers. Further, it is reported that large portions of land have to be kept fallow owing to shortage and high prices of bullocks in the province. With a view to help cultivators to meet this situation and to intensify the 'grow more food' drive, Government have decided to open a few tractor stations for making tractors availalble on hire for ploughing fields at Rs. 20 per acre. "Takkavi" loans may be also disbursed to meet ploughing charges.

A start with mechanical agriculture was also made in the E. Punjab. According to the scheme of tractor cultivation sponosred by the Govern-

1. See my article on "Land Colonisation" The Silver Jubilee Memorial Volume of the School of Economics and Sociology (Econ-vol.), 1947, pp. 116-127.

ment of India, sites have been selected in the Karnal and Ferozpore districts for major operation and also in the districts of Hissar, Rohtak and Lussiana for stationing the tractors. Some land was already ploughed and cultivated in Jullundur and Ambala. It appears that the Ministry of Agriculture is encouraging schemes for large scale mechanical cultivation in the E. Punjab for rehabilitation of refugees from the W. Punjab who do not possess necessary implements for cultivation of land lying in Ferozpur and Karnal districts.

In connection with increase of food crops in Madras Province, nearly 1,600 acres of land were levelled and ploughed with the aid of tractors and heavy iron ploughs. The policy of the Bombay Government with regard to mechanical traction is that it should be confined to deep ploughing for purposes of bringing wasteland under cultivation and for the eradication of weeds such as 'hariali.' Tractors which are not required for deep ploughing are to be disposed of to private parties, preference being given to the Taluka Development Associations and co-operative organisations. Schemes for development of wastelands are given effect to at places like Indoor, Hillur and Rampur in Kanara district and blocks allotted for settlers, largely refugees. Protection and improvement of 'khar' lands and reclamation of tidal lands by construction and maintenance of embankments in Bombay Province, and reclamation and development of waste and grass lands in the centrally administered provinces of Delhi and Ajmer-Merwara were also mooted out.

In this connection mention may be made about the Central Land Reclamation Organisation as proposed by the Food Grains Policy Committee and the six-year plan of reclamation as worked out by the Food and Agriculture Ministry, Delhi. The Food Grains Policy Committee in its final report recommend the establishment of a Central Board of Agricultural Planning, setting up of provincial Boards of Agriculture and an autonomous Central Land Reclamation Organisation with a capital of Rs. 50 crores, with a view to bridge the food deficit of about 3 million tons of food grains by reclamation and cultivation of cultivable waste lands of all types. The functions of the Central Organisation for reclamation are as follows: The Organisation's work will ordinarily be restricted to reclaiming land and making it available for the Provincial Boards of Agriculture for settlement and disposal. The actual cost incurred for each project will be recovered from the province or state in whose area the project lies in twenty equal instalments. The Committee are of the view that no area less than 10,000 acres should be entertained by the Central Organisation for reclamation and the reclaimed lands should be settled in such a way that the minimum size of each block of land, after parcelling, should not be less than 200 acres in size. The functions of the Provincial Boards of Agriculture are: (a) to recommend to the Central Board on suitability and availability of land for

reclamation in the Province (b) to assist the Central Organisation in the work of reclamation, (c) to advise the Provincial Governments about the agency for subsequent cultivation of reclaimed land and (d) to review and report to the Central Board regarding the progress of provincial food production plans.

The Ministry of Food and Agriculture of the Government of India have drawn up a six year plan of land reclamation. With the help of the number of tractors now in hand and by importing 1,000 tractors during the next three and half years, nearly 6 million acres of cultivable waste-land out of the total 65 million acres in the country, can be brought under cultivation. According to estimates, this may add only about 2 million tons of food grains annually to India's food resources. But still, there is a shortage of 1 million tons to the target of 3 million tons set up by the Food Grains Policy Committee. In order to reach this figure, approximately 10 million acres of cultivable waste-land will have to be reclaimed. The following is a rough estimate of the areas in different parts of the country.*

REGION	AREA	REGION	AREA
East Punjab	500,000 acres	Malwa Union	1 million acres
U. P.	1 million ,,	Madras Agency tracts	1 million ,,
Berar	200,000 ,,	Vindhya Union	500,000 ,,
Assam	4 million ,,		
Orissa	1 million ,,		

Total for the two cols. 10,200,000 acres

It may be noted that, although the contribution to food production made by cultivation of these lands may fall short of the estimates at least in the first three years, the benefits obtainable in the long run are unquestionably immense which amply justify the speedy and effective operation of all such schemes.

Conclusion: In short, the following main inferences clearly emerge out of the above discussion. Agriculture is increasingly mechanised and motorised for reasons connected with labour, technical progress and rational use of agricultural resources. Mechanisation on the whole, in countries where it has progressed, is considered as a boon to society in as much as it has secured higher wages to the labourer, larger yields and better quality products from the farm, and more income to the farmer to enable him to live and lead a happy farm life with expanded scope for the development of his intellectual and aesthetic faculties. It is found useful in correcting and supplementing the niggardly ways of nature as manifested in the qualities of climate, soil and other conditions. In India, although mechanised agriculture on factory farms as in the U.S.S.R. or in the U.S.A. is inconceivable in the foreseeable future, yet there exists a wide scope for improvement of the implements that are commonly used as well as for the manufacture of improved implements and other machinery

* Cf. 'The Hindustan Times' dated 13-8-48 and 1 The Times of India 22-5-48.

suited to the requirements of Indian agriculture. As the Industrial Commission have pointed out, improvement in agriculture will necessarily imply a growing mechanisation of its processes and may be expected to bring into existence large manufactured establishments to produce agricultural tools and machinery.[1] The need of machinery for reclamation and cultivation of waste-lands is indispensable. By gradually developing the systems of co-operative and joint farming, it is possible to benefit from the use of machines owned or hired from the government stations. There is ample work in this direction for the co-ordinated efforts of agricultural co-operatives, the Department of Agriculture and the Department of Planning and Development. The State, besides doing loud propaganda, can offer additional encouragement by way of subsidies and concessions regarding manufacture and transport charges on agricultural machinery and generally on all improved implements and provision of technical education at all levels.

MECHANISATION OF AGRICULTURE

by

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In view of the food-crisis and the growing pressure of population on resources from a long-term point of view, the problem of increasing the food-production in the country is becoming more urgent than it was previously. The stock solution for the problem would be that of introduction of new methods of cultivation which may ultimately be expected to lead to rationalisation of agriculture, and change agriculture from being, in the classic phrase, "a mode of life" into "a branch of production." Rationalisation of agriculture would ultimately involve the mechanisation of agriculture. Though this solution appears to be widely accepted, some doubts have been thrown out regarding its efficacy by economists of the Gandhian school as also by eminent scientists like Dr. Albert Einstein. To the scientific argument it may be difficult to reply; but it is not so difficult to reply to the main critics of mechanisation in so far as the burden of their criticisms and invective is merely that machinery creates unemployment. In what follows, an attempt is made to analyse the pseudo-theoretical arguments against mechanisation. The scientific arguments against mechanisation would also be considered only in so far as they are relevant from the purely economic point of view.

1. Cf. Report of the Industrial Commission, p. 22.

I

The Fetish Of Full Employment

The economic goal of any nation as of any individuals is to get the maximum results with the least effort. The whole economic progress of mankind has consisted in getting more production with the same labour. It is for this reason that men began putting burdens on the backs of mules instead of on their own, that they went on to invent the wheel and the waggon, the rail-road and the motor truck. Here is the beginning of a hundred thousand labour-saving devices.

All this is so elementary that one would blush to state it if it were not being constantly forgotten by those who coin and circulate new slogans. Translated into national terms this first principle means that our real objective is to maximise production. In doing this, full employment—that is absence of involuntary idleness—becomes a necessary by-product. But production is the end, employment is merely the means. We cannot continuously have full production without full employment. But we can very easily have full employment without full production.

Primitive tribes are naked and wretchedly fed and housed but they do not suffer from unemployment. China and India are incomparably poorer but the main trouble from which they suffer is primitive productive methods (which are both a cause and consequence of the shortage of capital) and not unemployment (India is having disguised unemployment). Nothing is easier to achieve than full employment once it is divorced from the goal of full production and taken as an end in itself. Hitler provided full employment with an armaments programme as the Egyptians had with "Pyramidenbau." The slave labour has full employment. Prisons and chain gangs have full employment. Coercion can always provide full employment.

It is surprising, in modern times for wages and employment to be discussed as if they had no relation to productivity. On the assumption that there is fixed amount of work to be done, the conclusion is drawn that a thirty-hour week would provide more jobs and would therefore be preferable to a forty-hour week. It is being considered a mark of genius for administrators to think of projects that employed the largest number of men in relation to the value of the work to be performed—in other words, in which labour was least efficient.

It would be far better, if that were the choice—which it isn't—to have maximum production with part of the population supported in idleness by undisguised relief than to provide full employment by so many forms of disguised make-work that production is disorganised. The progress of civilisation has meant the reduction of employment, not its increase. It is

because the world is becoming increasingly wealthy as a nation, that we are in a position to reduce child-labour, to remove the necessity of work for many of the aged and to make it unnecesary for millions of women to take jobs. The question is not so much whether there will be an increase in the number of jobs, but rather whether there would be an increase in production and what in consequence would be the standard of living. The problem of distribution is more easily solved, the more there is to distribute. In contrast to this is the opposition to mechanisation.

II

Does Machinery Create Unemployment?

Amongst the most viable of all economic delusions is the belief that machines, on net balance, create unemployment. Destroyed a thousand times it has risen a thousand times out of its own ashes as hardy and vigorous as ever. Whenever there is long-continued mass unemployment, machines get the blame anew. The belief that machines cause unemployment when held with any logical consistency leads to preposterous conclusions. Not only must we be causing unemployment with every technological improvement we make today but primitive man must have started causing it with the first efforts he made to save himself from needless toil and sweat.

To go no further back, let us turn to Adam Smith's *Wealth of Nations.* In this remarkable book, the author tells us that a workman unacquainted with the use of machinery employed in pin-making "could scarcely make one pin a day, and certainly could not make twenty, but that with the use of machinery he can make 4,800 pins a day." So already, alas, in Adam Smith's day, machinery had thrown out from 240 to 4,800 pin makers out of work for every one that it kept. In the pin-making industry there was already, if machines merely throw men out of jobs, 99.08% unemployment. Could things be blacker?

Things could be blacker, for the Industrial Revolution was yet in its infancy. Let us look at some of the incidents and aspects of that revolution. Let us see, for example, what happened in the stocking industry. New stocking frames as they were introduced were destroyed by the handicraft workmen (over 1,000 in a single riot), houses were burnt, the inventors were threatened and obliged to fly for their lives and order was not finally restored until the military had been called out and the leading rioters had either been transported or hanged.

Now it is important to bear in mind that in so far as the rioters were thinking of their own immediate or even longer future, their opposition to the machine was rational. For William Felkin in his History of Machine-wrought Hosiery Manufactures (1867) tells us that the larger part of the

50,000 English stocking-knitters and their families did not fully emerge from the hunger and misery entailed by the introduction of the machine for the next forty years. But in so far as the rioters believed, as most of them undoubtedly did, that the machine was permanently displacing men, they were mistaken for before the end of the nineteenth century the stocking industry was employing at least a hundred men for every man it employed at the beginning of the century.

Arkwright invented his cotton-spinning machinery in 1760. At that time it was estimated that there were in England 5,200 spinners using spinning wheels and 2,700 weavers—in all 7,900 persons engaged in the production of cotton textiles. The introduction of Arkwright's invention was opposed on the ground that it threatened the livelihood of the workers and the opposition had to be put down by force. Yet in 1787—twenty-seven years after the invention appeared—a Parliamentary inquiry showed that the number of persons actually engaged in cotton spinning and weaving had risen from 7,900 to 320,000, an increase of 4,400%.

In the depression of 1932, the game of blaming the machines for unemployment started all over again. Within a few months the doctrines of the group calling themselves Technocrats had spread throughout the country like a forest fire. It is not essential to go into the details of this thought. It is enough to say that Technocrats (and Gandhians also) returned to the error in all its native purity that machines displace men—except that, in their ignorance they presented this error as a new revolutionary discovery of their own. It was only one more illustration of Santayana's aphorism that those who cannot remember the past are condemned to repeat it!

The Technocrats were laughed out of existence but their doctrine lingers on.

III

If indeed it were true that introduction of labour-saving machinery is a cause of mounting unemployment and misery, the logical conclusions to be drawn would be revolutionary, not only in the technical field, but for the whole concept of our civilisation. Not only should we have to regard all further progress as a calamity; we should have to regard all past technical progress with equal horror. Every day each of us in his own capacity is trying to reduce the effort it requires to accomplish a given result. Each of us is trying to save his own labour, to economise the means required to achieve his ends.

Every employer, small as well as large, seeks constantly to gain his results more economically and efficiently that is, by saving labour. Every intelligent workman tries to cut down the effort necessary to accomplish his assigned job. The most ambitious of us try tirelessly to increase the re-

sults we can achieve in a given number of hours. The technophobes if they were logical and consistent would have to dismiss all this ingenuity and progress as not only useless but vicious. Why should freight be carried from Bombay to Poona by rail when we could employ enormously more men to carry it all on their backs?

Theories as false as this are never held with logical consistency but they do great harm because they are held at all. Let us, therefore, try to see exactly what happens when technical improvements and labour-saving machinery are introduced. The details will vary in each instance, depending upon the particular conditions that prevail in a given industry or period. But we shall assume an example that involves the main possibilities. Suppose a clothing manufacturer learns of a machine that will make men's and women's overcoats for half as much labour as previously. He instals the machines and drops half his labour force. This looks at first glance like a clear loss. But the machine itself required labour to make it, so here as one offset, are jobs that would not otherwise have existed. The manufacturer would have adopted the machine only if it had either made better suits for half as much labour or had made the same kinds of suits at a smaller cost. If we assume the latter, we cannot assume that the amount of labour to make machines was as great in terms of pay-rolls as the amount of labour that the clothing manufacturer hopes to save in the long run by adopting the machine; otherwise there would have been no economy and he would not have adopted it. So there is still a net loss of employment to be accounted for. But we should at least keep in mind the real possibility that even the first effect of the introduction of labour-saving machinery may be to increase employment on net balance; because it is usually only in the long run that the clothing manufacturer expects to save money by adopting the machine, it may take several years for the machine to pay for itself.

After the machine has produced economies sufficient to offset its cost, the clothing manufacturer has more profits than before (we shall assume that he merely sells his coats for the same price as his competitors and makes no effort to undersell them). At this point it may seem that labour has suffered a net loss of employment, while it is only the manufacturer, the capitalist who has gained. But it is precisely out of these extra profits that the subsequent social gains must come. The manufacturer must use these extra profits in at least one of the three ways and possibly he will use part of them in all the three: (1) He will use the extra profits to expand his operations by buying more machines to make more coats or (2) he will invest the extra profit in some industry or (3) he will spend the extra profits on increasing his own consumption. Whichever of the three courses he takes he will increase employment. In other words, the manufacturer, as a result of his economies has profits that he did not have before. Every rupee

which he has saved on direct wage is now being spent on indirect wages to makers of the new machine or to workers in another capital-goods industry, to makers of a new house or motorcar for himself or jewelry for his wife. In any case (unless he is a pointless hoarder) he gives indirectly as many jobs as he ceased to give directly.

But the matter does not and cannot rest at this stage. If this enterprising manufacturer effects great economies as compared with his competitors either he will begin to expand his operations at their expense or they will start buying the machines too. Again more work will be given to the makers of the machines. But competition and production will then also begin to force down the price of overcoats. There will no longer be as great profits for those who adopt the new machines. The rate of profit of manufacturers using the new machine will begin to drop while the manufacturers who have still not adopted the machine may make no profit at all. The savings, in other words, will begin to be passed along to the buyers of overcoats—the consumers.

But as overcoats are now cheaper more people will buy them. This means that though it takes fewer people to make the same number of coats as before, more overcoats are now being made than before. If the demand for overcoats is what the economists call elastic, that is if a fall in the price of overcoats causes a larger total amount of money to be spent on overcoats than previously, then more people may be employed in making overcoats than before the new labour-saving machine was introduced. We have already seen how this happened historically with many trades in Great Britain during Industrial Revolution.

But the new employment does not depend on the elasticity of demand for the particular product involved. Suppose that though the price of overcoats was reduced from a former price, say, of Rs. 50 to a new price of Rs. 30—not a single additional coat was sold. The result would be that while consumers were as well-provided with new overcoats as before, each buyer would now have Rs. 20 left over that he would not have had left over before. He will therefore spend this Rs. 20 for something else and so provide increased employment in other lines.

On net balance, in the long run, technological improvements increase economies and efficiency but do not throw men out of work.

Not all machines again are labour-saving; some of them improve the quality of the work done. Others perform operations that direct human labour could not perform at all, still others bring into existence objects and services such as X-rays, and radios and synthetic rubber that would not otherwise even exist.

IV

There is also an absolute sense in which machines may be said to have enormously increased the number of jobs. The population of the world today is three times as great as in the middle of the eighteenth century before the Industrial Revolution had well got under way. Machines may be said to have given birth to this increased population for without the machines the world would not have been able to support it. Two out of every three of us may be said to owe not only our jobs but our very lives to machines.

The function of machines is not primarily *the creation of jobs, it is the increase of production, the raising of the standard of life, the increase of economic welfare.*

Full employment is a characteristic precisely of those nations that are retarded industrially. Where full employment already exists, new machines, discoveries and inventions cannot—until there has been time for an increase in population—bring more employment. They are likely to bring more unemployment.

What machines do, to repeat, is to bring an increase in production and increase in standard of living. They may do this in either of two ways. They do it by making goods cheaper for consumers or they do it by increasing wages because they increase the productivity of the workers. In other words, they either increase money wages or by reducing prices they increase the goods and services which the same money will buy. But in any case machines increase real wages.

Of course, in the short-run some workers will be thrown out. That is a personal tragedy which is incidental to all industrial and economic progress.

V

Mechanisation of Agriculture

The experience of mechanisation in the early days of the Industrial Revolution has been all to the good. Mechanisation involves large-scale farming if it is to be profitable. This naturally spells the doom of the pocket-handkerchief midget farms that pass at present as the individual holdings. If agriculture in India is to be made profitable, it would necessitate mechanisation of agriculture. Our urgent food-problem cries for solution —the only solution being mechanisation of agriculture. No doubt mechanisation would cause certain persons to be thrown out of their occupation. But if we are to go ahead with the reform of Indian mass-poverty, mechanisation is essential.

At present, it is being facilely argued that since at present we have got large masses of cheap labour, we should go on using methods of pro-

duction which would use relatively large volume of labour and a smaller volume of capital. But this argument ignores two fundamental objections which may be raised very pertinently: though use of labour would increase employment, would it increase real productivity? And it is the increase in real productivity that is significant for raising the standard of living of the people.

It may also be asked as to why wages of labour are low, (or labour is cheap). It is *obvious that wages are low because productivity per man-hour is a function of technique rather than of anything else.* That automatically involves the use of machinery. The stereotyping of existing productive technique is the demand of reactionaries trying to seek as Bastiat's famous candle makers were doing, "Protection against the sun."

VI

Various schemes of large farming are expected to throw a large number of persons out of their occupations. It was estimated by Sir M. Visveshwaraya in 1934 that some 85 million persons would have to find alternative jobs if agriculture were mechanised. In the light of increased population pressure, the number of displaced persons is bound to be greater. In a recent book by Dr. Tarlok Singh *Poverty and Social Change* (1945) it was estimated that the adoption of his scheme of Joint Village Management would involve the displacement of some 22 million persons. These are stupendous figures but unemployment would be a necessary surgical operation of the Indian body economic.

Let it be more frankly recognised that we are in an overpopulated country and the unemployment is a visible index of overpopulation and not of mechanisation. Mechanisation would increase the per acre as also per capita output and bring a greater measure of prosperity. The warning which was sounded by Dr. Einstein in an interview with Prof. A. Jha that India should not go in for synthetic fertilisers as they cause a deterioration of the fertility of the soil is not applicable so much to mechanisation. The same argument was used last year with great effect by the Hon'ble Mr. V. L. Mehta (in his Presidential address at Shriniketan). Besides, its scientific validity is yet to be fully established. We should not ridicule mechanisation before its evil effects are scientifically demonstrated beyond doubt.

VII

Lastly come the arguments from the point of view of defence. It is coming to be increasingly realised that peace is only a breathing space between wars. It therefore behoves us to put "defence" at a level higher than "opulence". This would involve the pursuit of self-sufficiency in all matters including food.

Besides, for purchase of food today we have to go abroad with a begging bowl and waste hard-earned foreign exchange at inflated prices. Will it not be more fitting if the same exchange is used for purchase of tractors and other mechanical equipment rather than for purchase of food ?

VIII

It must also be pointed that mechanisation would increase the real purchasing power of the people and would thus have a leverage effect on demand for other products. This would cause an increase in demand for labour in those lines which may absorb the displaced workers in agriculture (if we assume them to be mobile between occupations and jobs) and in that case there may not be as great an unemployment as we are led to assume.

ECONOMICS OF MECHANISATION OF AGRICULTURE

By

D. KRISHNA IYENGAR, M.A., F.R.ECON.S.

Mysore.

The world is short of food today and a number of countries are either suffering from or fearing famine conditions. Under such a condition, countries agricultural in nature and set up, must arrange their economy properly, particularly their agricultural activities and rectify man's misuse of soils. They must realise that their agricultural systems have greater capacities for producing foodstuffs and raw-materials than ever before. The present difficulties and shortage have arisen from many sources.

Causes of Shortage

The ravages of war in agricultural systems and in agricultural populations and capital and the effects of the terrible war on transport and international transfer of supplies are the important causes. The present shortage is bound to accentuate the differences, in respect of agricultural progress and security of food supplies, between industrially developed countries which would get their supply of food stuffs and raw-materials easily and the countries like China and India which are suffering from shortage inspite of their vast resources. The conditions in these countries only illustrate in extreme form the well known facts that agricultural and industrial progress have been very unevenly distributed and that consequently it is possible to find modern and efficient systems to produce more. The chief requirement for a full flow of food stuffs will be the revival of industrial systems and the offer of industrial products to agricultural uses

and consumers. More than seventy per cent of the cultivators in India are illiterate and live in indigence and their life is a perpetual struggle to eke out a living from an uneconomic plot of land. The man land ratio is very high and the number of people supported by land has been increasing. As far back as 1880, the Famine Commission observed that "the numbers who have no other employment than agriculture are greatly in excess of what is really required for the thorough cultivation of land."

Efficiency of Agriculture

The best and the most simple evidence of the rise of efficiency of agriculture is the reduction of the proportion of occupied persons required to produce food stuffs for the whole consuming population. This condition of raising efficiency is a *sine qua non* of general industrial and social progress. One pre-requisite of each step in efficiency in agricultural production is to increase agricultural output per person engaged in non-agricultural occupations. Increase in the proportion of industrial and urban population is an indication of efficiency of agricultural system in most of the western countries, but it is not so in India. Inspite of the increasing proportion of population in agricultural occupation, the production of food stuffs in India is not sufficient to maintain its own population.

Agricultural improvement and efficiency take many forms and the most important of these are: improvements in means and methods of cultivation; discovery, selection, and breeding of plants for specific purposes; selection and breeding of animals; improvements in means and methods of harvesting and storing products; changes in sources of power; control of disease and insect pests to secure certainty or regularity of yield of crops; control of disease of animals; discovery of mineral and industrial sources of plant requirements, and improvements in methods of preparation for use; increase in knowledge of animal nutrition, and of principles of selection and breeding of plants and animals.

Modern wars have stimulated progress in agriculture in most of the western countries and the application of scientific knowledge and of capital and mechanical power have greatly been increased in most of these countries. The process of making agricultural production more certain, economical and efficient is a continuous one and the net result is the increasing productive capacity in agriculture. But the problem of today is to apply those improvements to our agriculture also. Agriculturists must always use the criterion of output per unit of human labour, per person, per man-day and per man-hour and it is on these that the average standard of remuneration and standard of living depend.

U.S.A.

One of the most important methods of agricultural improvement has been the introduction of different farm-machines. As a result of engi-

neering advances, there exists farm machinery suitable even to the small farms. The one country which has tremendously increased the technical porgress and mechanical equipment in agriculture is America. Some of the typical machines are worth mentioning.

Tractor cultivation has become very common in U.S.A. The new automatic pick-up hay baler, the self-propelled combine and cotton picker, the harvestor-thrasher are the most important. The pick-up hay baler makes a one man job of what has usually been a four-man job and this makes unnecessary for the farmer to draft his family for field work. Besides this, the baler eliminates the use of two other machines. The mechanical cotton picker is the result of more than 40 years of engineering work. It can make an important contribution towards reducing the cost of production. The machine will harvest in a day about as much cotton as could be picked up by forty to fifty hand pickers.

The greatest effect of technological change in farm machinery is manifested in soil conservation work. Improved farming practices have been developed by the soil conservation service which not only helps to preserve top soil but also aids in rebuilding its fertility. Refrigeration system like electrical equipment is another mechanical improvement which made the work of the farm-women easier. Without mechanisation the American farmers could not have produced the crop necessary to sustain their war efforts and maintain their large population. On thousands of farms, farmers, their wives and daughters, with the aid of machinery carried on cultivation successfully, despite the absence of young men who went to war, and produced as much crop, some times more than the quantity which was being produced previously. It is chiefly due to technical changes in mechanical equipment that make even small farms more secure in America and this improved their ability to compete with larger farms, making them at the same time efficient business concerns and better places to live.

Russia

Agriculture in pre-revolutionary Russia was completely under the mercy of the elemental forces. Farms were small, farming methods were extremely on a low level and harvests were unstable and fluctuating. After the revolution the land was nationalised and turned over to the peasants free of charge. The peasants voluntarily began to unite their tiny holdings into large collective farms and this made it possible for them to apply scientific methods of farming and to employ tractors, harvestor combines and other up-to-date agricultural machinery. The number of collective farms rapidly grew from 1,600 in 1928 to 217,000 in 1945, embracing more than 85 per cent of the peasant holdings. It is due to this system of co-operative farming that Russian agriculture now is one of the

most scientific and most highly mechanised occupations and is run on the largest scale of any in the world.

Mechanisation of agriculture in Russia has not created a superfluity of labour; on the other hand, the labour power released by the machine is absorbed in live-stock-breeding, vegetable and fruit growing and other branches of collective farming. Soviet farmers have built their collective farms on ashes and ruins and more than 26,000 tractors and 40,000 other agricultural machines and more than 3 million heads of cattle were supplied to them by Government. The Soviet Government have prepared a five year plan for 1946-50, providing for a very big increase in the supply of food-stuffs and raw-materials.

F.A.O.

The Hot Springs Conference on Food and Agriculture recommended in 1945 that every country should promote healthy and efficient agriculture capable of producing that part of the nation's food which is required for home consumption at the lowest price consistent with the provision of adequate remuneration and decent living conditions for farmers and workers, with reasonable return on capital invested. Most of the countries have attempted to improve their agricultural systems and by means of mechanisation they have improved their agricultural production. But the conditions in India are otherwise. Even in the very first year of India's freedom, food and agricultural problems have become very much complicated and the partitioning of the country has added some more troubles.

India's Problem

The most important problem which confronted the Indian union is how to increase the food stuffs and other main agricultural commodities. It is not capable of easy solution as the attention of the Government is diverted to other more urgent matters such as the refugee and defence problems. The deficit had unavoidably to be met by increasingly heavy imports from abroad, amounting in value to nearly Rs. 100 crores in 1946-47.

The Government of India set up the Food Grains Policy Committee in September 1947 and it has recommended a target of ten million tons for increased food production of which 4 million should come from multi-purpose irrigation and electricity projects, 3 million tons from new lands to be reclaimed by Government and the remaining 3 million tons from such measures as mechanisation, distribution of improved seeds and manures.

Cultivation by tractors is not entirely a new innovation in India, but a great impetus was given to it by the Central Government in May 1947, when 200 heavy tractors and bull-dozers were purchased from the United States Army equipment and were used for land reclamation. About 45,000 acres in United Provinces and Central Provinces were brought under cultivation. It was hoped that large areas of jungle lands in certain provinces

and States and similar vast areas infested by the weed known as 'Kar' in Central India and 'Hariali' in Bombay and Madras might easily be brought under cultivation after deep ploughing by heavy tractors.

Low Production in Agriculture

The low productivity of Indian agriculture is proverbial and this is due to the failure of applying modern scientific methods to it. During the eighteenth and nineteenth centuries, there was economic transformation in European countries, and they have all adopted a new system of crop rotation, better method of sowing and reaping, the use of chemical manures and general application of new scientific knowledge through mechanical development to all the related aspects of the economy. New economic institutions were developed and the entire way of life was altered; and in this great effort the State played a prominent part.

Indian economists after Gokhale and Ranade were alive to the situation here and pointed out the absurdity of following an alien agrarian policy in India. The various Famine Commissions and Committees have observed the seriousness of the agrarian problem and almost nothing was done either to organise agriculture on a new scientific basis through mechanical development, or to foster industries so as to relieve the pressure of population on land. The recommendations of the Royal Commission on Agriculture covered almost every aspect of agriculture and rural life, but left out land reforms, irrigation cess, and mechanical development. The popular ministries in 1937 tried to take up the subject, but the war intervened, and they could not do anything. The Government of India appointed an Agricultural Policy Committee, which did not meet at all.

Agriculture in India has become a deficit economy. The land system here contains all the evils of a feudal system. The pressure on the land is too great. Holdings are getting smaller and scattered. Co-operation has almost failed to provide the required agricultural finance; facilities for proper grading or standardisation of agricultural produce are very scanty. Land taxation is iniquitous and the suitable organisations for administration that existed in rural parts have disappeared. The Agricultural Research Institute at Pusa, the Indian Council of Agricultural Research, the Central Cotton and Jute Committees, the Agricultural Credit Department of the Reserve Bank etc., have no doubt done some research work, but they have not helped any large scale mechanical development in agriculture to increase the production. Inspite of the efforts of the Servants of India Society, the All-India Spinners' Association, the All-India Village Industries Association, the Harijan Sevak Sangha, and the Kisan Sabha, research and new knowledge have not yet fertilised Indian agriculture and mechanisation has not yet penetrated into the actual farms. As a result of a peculiar system of idustrialism in India,

the old balance between agriculture and industry is destroyed. The villagers lost their subsidiary occupation. There is more and more ruralisation more and more dependence on agriculture, more and more pressure on land. People in rural parts are sinking into greater poverty, which seems beyond repair, due to their very low income.

Scope of Mechanical Development

Modern science has contributed to man's control over Nature through developments in engineering and machinery. Engineering gives control over technique through mechanical development in the field of production, transport, housing and cultivation. Mechanical engineering has brought about improvements in tools, implements and machinery. The machine age has elevated rural life by providing new agricultural implements and this has also made large scale farming most successful in U.S.A. and U.S.S.R.. In India there is immense scope for improved implements and tools which can be utilised with advantage by farmers, even on the small holdings. Indian peasants and artisans require cheap, light and simple machinery.

It is said that owing to general poverty of the villages, any good scheme of rural electrification and its use on the land on a western scale would be difficult and impossible in India; besides, India being a country of small farms and scattered holdings has not much scope of improvement in this direction. But this fact should not prevent any possibility of extending the use of electricity to the villages wherever possible. France is a country of small farms with 95 per cent farm families, Japan and Germany with 90 per cent, Denmark with 85 per cent, Holland with 100 per cent; they have all provided a Central Electric Power Station Service. This being the case, India has a great future and greater scope for development in rural electrification. It would be wrong to say that our villager does not realise the use and value of cheap electricity both for agriculture and industry. Japan has created such immense facilities by installing small factories in rural areas. Such cheap electric power is one of the first needs of India and it must have precedence over all other mechanical development.

Mysore

What is true of India will certainly apply to Mysore. The economic conditions of the rural people and agricultural production have not been improved in Mysore. An enquiry into the economic condition of rural families in about 258 villages selected all over the State reveals that in many places the yield from land is very low and the income of the ryots is appallingly meagre. In spite of the State Agricultural Department having demonstrated the advantages of better seeds, better manure, and better methods of cultivation, these methods of cultivation have not been taken up by ryots to effectively increase their production. There is a clear deficit to the value

of more than a crore of rupees under food crops and another crore of rupees under cotton and Indian piece-goods. The problems of Mysore agriculture are how to increase the production of paddy, grain and cotton to meet the requirements of the people and how to increase the production of exportable crops to compensate for the large imports. The State should, therefore, turn its attention towards mechanisation of agriculture.

The total area under cultivation is going down and this is an indication that agriculture is deteriorating. The resources of many agriculturists do not permit of their sinking large wells, installing electric pumps or use of up-to-date machinery. Geographically, Mysore has been divided into two parts, Maidan and Malnad. The Maidan has much greater area than the Malnad. 46 per cent of the total area under paddy, 59 per cent under areca-nut, 15 per cent under sugarcane, the entire area under coffee, tea, and cardamom and pepper, are in Malnad. It is the forest of Malnad that produces the most valuable timber and sandal wood. Though the area comprising Malnad is small, yet it contributes very largely to the resources of the State. It is unfortunate that this area has been neglected and the cropped irrigated area is declining from decade to decade.

Agriculture in Malnad requires large capital and labour and it has given rise to large landed proprietors on the one hand and a class of agricultural labourers on the other. The labour problem has become very acute there owing to the migration due to unhealthiness which has resulted in the decrease of the cropped area. Under these circumstances, there is greater scope for mechanisation of agriculture in the Malnad than in the Maidan.

With nearly 8 million acres of lands under occupancy, Mysore does not possess even ten tractors. What a poor specimen for mechanisation of agriculture! Some of the Malnad land owners are capable of purchasing them but they have not done so yet. Even in regard to power lift irrigation, there is ample scope for improvement. Inspite of the availability of electric power in many parts of the State, land owners have not come forward to avail themselves of the opportunities. As the resources of many agriculturists do not permit of their sinking large bore wells or installing electric pumps with their own money or borrowed capital, Government of Mysore may consider the desirability of following the example of the United Provinces where such water is raised at Government cost and sold to the agriculturists at a fixed rate per 1,000 gallons.

If agriculture is to be improved in Mysore, it should be mechanised and the depopulation of Malnad should be stopped. The indigenous population should be protected from malaria and other diseases, and their woefully low standards of life, food, clothing and shelter have to be improved. The Malnad is a treasure house of natural resources capable of yielding much

higher income than at present and the Government cannot afford to neglect either the region or its people. By proper immigration from the the Maidan to Malnad, not only the excess population on land in the Maidan would be relieved but the Malnad can be made capable of supplying both food-stuffs and raw materials through the help of mechanisation.

Mysore is a land of villages, but unfortunately there is all round deterioration in them. The hereditary village officers have lost their influence. There is no leadership. The time honoured custom of communal work has disappeared. Factions are rife, indiscipline is increasing. Eagerness to repudiate obligations is growing. The village panchayats have not yet adjusted themselves to the changed condition. Maintenance of tanks has been completely neglected. The civic sense and responsibility to the neighbour have been completely forgotten. To crown all these, the urban areas are receiving greater attention than the rural. Laziness, unemployment and under-employment are on the increase. Illiteracy and ignorance are rampant and discontent is reigning.

The most important remedy for all these ills is mechanisation of agriculture and decentralisation of industries. Electric power is abundant in Mysore and available in all parts of the State. By introducing a system of development of cottage industries and by using power on an increasing scale, the excess of population on land may be drawn into non-agricultural pursuits. By mechanisation, production of food-stuffs and raw-materials could be improved. Thus the future progress of Mysore depends upon mechanisation of agriculture on the one hand and a form of decentralised industries on the other.

FARM MECHANISATION

by

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Displacement of labour by mechanisation alone is often thought of as a great disturbance to social peace. But this problem exists in many ways too. Because there is over-abundance in man power, it does not mean that it should be wasted in inefficient and shoddy work. Savings in man hours occur in several ways. Replacement of a dull axe or plough, a planned division of work, less waste in walking, proper arrangement of farm buildings, feeding devices, in fact all farm simplification methods reduce man labour. Have those who cry against mechanisation thought of providing for labour displaced in consequqence of efficiency methods?

Farm mechanisation alone has not reduced the man-hours per unit of farm production. According to the bulletin of the U. S. Department of

Agriculture, October 1947 on 'Progress of Farm mechanisation,' savings in man-hours by farm mechanisation from 1917-21 to 1944 amounted to 48% of total savings from all developments. The bulletin says:—

"The remaining 52% of the total was composed principally of savings because of increased production per acre of crop land, increase in size of livestock enterprise, increase in production per animal, spreading of overhead over a larger business and several other factors. Those others included changes in methods of handling enterprises, elimination of operations, work-simplification features, and increase in some custom-hired operations."

Mechanisation again corrects the natural defects of unequal and untimely rainfall. A rain or storm narrows the planting seasons. There are weather hazards in cultivating and harvesting seasons. If only there could be quick planting on a twenty-four-hour schedule, the crop could be made to mature within the season. If only there was quick harvesting, the crop could be stored or rains would destroy it. There are critical jobs which should be quickly done, and can be done only by machine and power. Hand power and bullocks fail to be useful to save a crop. Machine equipment and power though uneconomic on such occasions becomes economic as by the other method one stands to lose the whole crop. Again a ground becomes hard owing to scarcity of rainfall. The plough operated by bullock power fails to break this ground. Seasons are again extended with the aid of irrigation and electric power and more crops are raised. With the growing of more cattle feeds, animal husbandry provides supplementary occupations. The general-purpose tractor on rubber tires fulfils a role in increasing the yields. It is a great corrective to the deficiencies of nature which the hand-plough and the bullock will never be able to rectify. With the working facilities of the tractor, the application of seeds to suit the range of seasons, and a knowledge of crop responses to fertilisers, the reaction of the weather and the seasons on crops has been a great deal mitigated.

The history of agriculture is one of the release of the agriculturist from craft labours and its transformation into a wholetime business. The only way by which we can protect the handpower economy in agriculture is by raising tariff walls to prevent cheap commodities produced by machine and power, from entering the country.

The consequence will be less crops less consumption more monotony and drudgery in work, less leisure, less talent, and less power of resistance to foreign exploitation.

Mechanisation does not mean displacement of labour. The worker has to take care of power tools instead of hand tools. The same hard work is required. Quick completion of the job and less effort are the advantages. The bulletin referred to above says:—

"From 1939 to 1945 gross production increased considerably more than during the previous 21 years. But total man-hours required in farm operation did not decrease—instead *they increased one per cent.* Labour saved because of greater speed in doing farm jobs by the use of modern machines has not always meant the release of farm workers. Rather the large volume of business developed through the introduction of more intensive enterprises and through more production per acre and per animal, has absorbed much of the labour that would have been released because of mechanisation."

Though mechanisation does save hand labour, it cannot substantially eliminate it. According to the bulletin of the U.S.A. Department of Agriculture, hand labour in wheat and corn was 25% and 31% respectively of the total hours spent in farm work. Generally about half the work was hand work if we consider the man hours spent in all crops. In livestock it was 75%. It was difficult to reduce handwork in such crops as fruits, nuts, vegetables, tobacco and potatoes. Fruits and vegetables require hand labour particularly in making attractive packages of higher grades. Farm maintenance work estimated as 15% of farm labour is generally done with hand tools by hand power. It is undeniable that a great saving in man-hours has been achieved by the use of machines and power. But it is necessary to dispel the common belief that introduction of machinery in agriculture would avoid the use of hand labour. More production of crops and livestock as a result of mechanisation will need more hand-labour than at present.

There are a number of small farms in the U.S.A. which suffer under similar disabilities as the small holdings in India in the application of machines. Tractors, trucks, hay balers, corn pickers, grain thrashers cannot be individually maintained. They will need joint ownership. Small machines too have been devised for small areas and intensive agriculture. Tractors suitable for small areas with low yields have also been devised in the U.S.A. The pattern of machines will have to vary according to the type of farming, the nature of the soil, and the finances of the small holder. The use of tractors is also conditioned by the crop prices and the prices of tractors.

Small holders, particularly relatives, consolidate their holdings in partnership. They pool their lands, machines, and livestock. They buy power equipment in partnership. Sometimes they purchase second hand tractors at cheap prices. While they raise crops individually, they join to own tractors for other than farm work as thrashing and combining. Fruit farmers hire tractors for the season. The crop sharers in the southern plantations use the equipment owned by the home-farm.

The object of this note is to dispel some of the false notions entertained about mechanisation. At the same time Indian conditions should not be forgotten. The existence of large unused manpower compels us to proceed cautiously. No one can object to the use of tractors for the reclamation of undeveloped lands which cannot be quickly done by hand. The use of such machinery and power in agriculture which thereby increases scope for employment will equally be welcomed. While mechanisation is bound to come and ought to proceed on a planned basis, we cannot forget the urgency of introducing better seeds and fertilisers along with mechanisation.

ECONOMICS OF MECHANISATION OF LIFT IRRIGATION IN THE RAVER TALUKA *

by

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The value of lift irrigation is long recognised in Raver Taluka because it is a tract of precarious rainfall. The lifting appliances are of two kinds, viz. the leather bag, locally called "Mhote," lifted with the help of bullock-power, and the mechanical pump, lifting water with the help of power generated by an oil engine.

There are at present 200 engines lifting water for irrigating 1,429 acres out of 6,298 acres of garden land and out of 1,23,507 acres of cultivated land in the Taluka. About 40 years ago, the first engine was installed. Their number rapidly increased after the out break of World War II. Mechanical pumping is mainly used for growing bananas.

Causes of rapid and remarkable increase in mechanisation of irrigation.

Bullocks employed for lifting "Mhote" have to be strong and of good quality. Such bullocks are not available locally. They used to be imported from the adjoining province of C.P. or from Malwa. But after the outbreak of the war, the import of bullocks from these areas has been prohibited. The price of fodder soared higher and still higher with the result that it is now ten times more than what it was during the pre-war days. Besides, bullocks frequently suffer from several infectious diseases and incidental disabilities such as periodical swelling of the neck. Consequently, the grower's investment in bullocks is either completely lost or receives costly set back at least for the time being.

* Raver Taluka is in East Khandesh, Bombay Presidency.