

MECHANIZATION IN INDIAN AGRICULTURE

Dissertation submitted to the
University of Poona
in partial fulfilment of the
requirement for the
Degree of

MASTER OF PHILOSOPHY
IN
ECONOMICS

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AUGUST 1982

(11)

ACKNOWLEDGEMENTS

I am indebted to Dr. Ashok K. Mitra for the help and encouragement during the course of preparing this study. My discussions with him were very useful in determining the final shape that this work has taken.

My thanks are also due to the authorities of the Institute for awarding me a U.G.C. fellowship without which this work could not have been completed.

Finally, I am grateful to Mr. K.P. Limbore for typing the manuscript very neatly.

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CHAPTER I
INTRODUCTION

It is a common human tendency to endeavour to get maximum output with minimum effort. Many inventions and innovations owe their origin to this tendency. In the agricultural sector such innovations display themselves in the form of farm mechanization. In fact any use of mechanized power in place of human/animal power for agricultural operations amounts to farm mechanization. Agricultural mechanization is the introduction of machines of increasing complexity for completion of one or several crop production or other agricultural operations. Mechanization is a continuous series of introductions. Substitution of the iron bullock plough for the wooden plough is a relatively simple step. The substitution of tractor power for bullock power is a relatively complex mechanization process. Mechanization consists in either replacing, or assisting, or doing away with both the animal and human labour in farming by mechanical power wherever possible.

Some broad types of mechanization, common to developed and developing economies are:

- (1) The type of mechanization which is related to the widening of the resource base. In this case there is an actual addition to effective physical resources. Examples are tubewells for tapping groundwater and crawler tractors for reclaiming forest land.

- (2) Another type would be concerned with enhancing the value of resources without necessarily effecting a physical addition to them. An example is tractors which are used for land levelling.
- (3) Another category comprises all those numerous mechanical means whereby efficiency is imparted to agronomic practices, whether these are related to soil or water, seed, fertilizers or pesticide. An example is the seed-cum-fertilizer planter which aims at accurate placement of seed and fertilizer at proper depths and appropriate intervals in a manner unattainable by manual means. In the same category are operations such as aerial spraying for plant protection.
- (4) Then, there are those mechanical appliances which assume special significance when the supply of labour is temporarily unable to meet the demand. To this group belong machines such as reapers, threshers and combines.

It is also necessary to take note of that important sector of mechanization which covers various post-harvest stages.

- (5) In some areas, it is necessary to dry the harvest as soon as it is reaped. This occurs when the main crop is harvested during rains. Driers are an extremely important mechanism in such a situation.
- (6) Then there is storage. One can cite, for example,

cold storage as a very valuable adjunct to the production of potato, vegetables, fruits and other perishable foods.

- (7) There is also the mechanization connected with the processing industry, including on the one hand food preservation and canning and on the other rice milling and so forth.

Thus machines can be introduced in almost all farming operations starting from the breaking up of the soil to the sale of the product. Where this is so, the process is one of 'complete mechanization', and is common in developed, industrialized economies. Developing economies, which are still in the early stages of economic development have introduced what is commonly known as 'Partial Mechanization' where only a part of the farm work is done by machines. It therefore appears that the world to-day is witnessing two contrasting trends of evolution of farm management systems. In one system occurring in countries like U.S.A., Canada, Australia and U.S.S.R., farm operations are highly mechanized. In the production of rice, for instance, the sowing of seeds is done by airplanes and the harvesting of the crop by special combines. In the other system however, found in many of the developing countries including ours, farm mechanization is still in its early stages and only a few of the agricultural operations are mechanized.

Farmers, whether in the developed or developing economies, mechanize farm operations when the biological

sources of energy, e.g. human and animal labour, become costlier than the mechanical sources. There is a secular tendency everywhere, for the biological sources to become costlier than the mechanical sources. This is mainly because of the labour-saving bias of technological change as well as the increasing ease with which capital can be substituted for labour in agriculture and partly because of the rise in the cost of human and animal labour relative to that of machines and fuel.¹

Technical progress and industrial development facilitate the ease with which capital can be substituted for labour and also to reduce the cost of machines and fuel. On the other hand, economic development and the growth of per capita income raise the cost of biological sources of energy, by increasing the demand for labour in the non-agricultural sector. Also, in view of high income elasticities of demand for milk and meat, it becomes more profitable to allocate the feed resources for augmenting the supply of such animal products than for maintaining draft animals. The increase in income of farmers raises their investible surplus as well as their credit worthiness for the purchase of machines. Besides, as the income of the farmer increases, the desire to lessen the drudgery and

1. Rao, Hanumantha, C.H., Technological Change & Distribution of Gains in Indian Agriculture, p.23, Institute of Economic Growth, Delhi, The Macmillan Company of India Limited, 1980.

hard work asserts itself. Farm mechanization enables him to get more leisure time.²

Mechanization of agriculture has thus proved to be another technological innovation for increasing the per capita productivity of agricultural occupation. It played a very crucial role in economies like U.S.A., Canada, Australia etc. where the land man ratio was very high and where a lot of virgin land was lying without being cultivated owing to shortage of man-power. The average size of holdings in England and Wales for the year 1946 was 83 acres and for U.S.A. it was 174 acres in 1940.³ Thus it was possible for a small number of cultivators to cultivate a big piece of land and increase the agricultural production of the country.

Moreover, in western countries there was shortage of labour due to either the lack of pressure of population on land or to the unattractiveness of agricultural wages in comparison with industrial wages. This tendency influenced to a great extent the rapid advance of agricultural mechanization.

Availability of capital was another factor that promoted mechanization in western economies. Mechanization demands a very large amount of capital investment which was

2. Ibid, p 23-24.

3. Bhattacharjee, Jyotiprasad, Mechanization of Agriculture In India: Its Economics, p 8, Calcutta, Modern India Press, 1949.

readily available in U.S.A., England, Canada etc. Also, in these countries heavy industry and processing factories had developed so that tractors and other farm equipment could be produced on a large scale.

Finally, availability of a certain standard of mechanical knowledge and technical education of those who are expected to handle machines, an important precondition for mechanization, was present in western countries. The farmers must have "some basic training in mechanical and electrical principles and a general knowledge of how the machines work, especially internal combustion engines and simple electrical machines and devices."⁴ This is necessary, not only for the proper handling and operation of the machines but also for their proper looking-after and maintenance. For, unless the farmers themselves can do simple repair work and understand the minor and major defects that the machines show, the cost of repairs, renewals and depreciation would become almost prohibitive and secondly, the actual repairs etc. would involve considerable delay and difficulty resulting in stoppage of farm operations. It was therefore recommended by the Australian Rural Reconstruction Commission (1945) that technical training should be imparted to the farm workers either through technical schools or as a part of general education.

In light of the above discussion it therefore appears

4. Ibid., p 20-21.

that the conditions and pre-requisites necessary for the use of mechanical appliances in western economies exist and hence mechanization is being easily adopted without any economic or social dangers.

The question that now arises is "Do the objective conditions justify the use of mechanical power in Indian agriculture?" In other words, "are the conditions in agriculture favourable to mechanization"? It is therefore necessary to discuss how far the pre-requisites for technological change in agriculture are present in India.

1. Land System:

Land system is the most important institutional condition influencing the introduction of improved agricultural technology. In India there exists a "complex variety of tenures and tenants" which are economically inefficient.⁵ There is excessive concentration of land among a few owners, informal tenancy arrangements, and a vast mass of landless labourers. The sub-tenants, tenants-at-will and crop-sharers do not enjoy any security of tenure and rent even now as they have not yet been brought under the purview of state legislation. Owing to their uncertain and insecure position, the co-operatives and commercial banks are naturally reluctant to provide loans to the tenants. The Planning Commission observes "..... the new strategy requires heavy investment in land shaping, infra-structure

5. Basu, Ashok, Technological Possibilities of Indian Agriculture, p 35, Calcutta, Firma KLM (Pvt) Limited, 1978.

and inputs, which investment a tenant is normally not willing to make without a clear indication of his right to the usufruct from his toils."⁶

The ceilings provisions, too, are full of loopholes. In general, the issue of land reform in India is more political than economic.

2. Size of The Farm:

It is a well known fact that India is a land mainly of small peasant farms which are run on the principle of subsistence farming. The holdings are small, sub-divided and fragmented into tiny parcels of land. The average size of a holding is 2.30 hectares and the number of small size holdings are pre-dominant.⁷ A clear picture on the distribution of operational holdings⁸ by size of holdings is presented below in Table A.

From Table A it can be seen that there is considerable inequality in the distribution of holdings. In 1970-71, 70 per cent of the holdings belonged to the size group-less than one to two hectares and accounted for 21 per cent of the cultivated area. In 1976-77 their number increased to 72 per cent and accounted for 24 per cent of the cultivated

6. Draft Fifth Five Year Plan, (1974-79), p 42.

7. Naidu, I.J., All India Report On Agricultural Census, 1970-71, p 41, Government of India, Ministry of Agriculture and Irrigation.

8. An operational holding is all land cultivated by a person irrespective of whether it is owned by him or taken on lease.

Table A: Distribution of Operational Holdings by size of Holding 1970/71 and 1976/77

Size of holding	1970-71		1976-77	
	Number of holdings (million)	Area (million hectares)	Number of holdings (million)	Area (million hectares)
Marginal (less than 1 hectare)	36.20	14.56	44.53	17.50
Small (1 to 2 hectares)	13.43	19.28	14.70	20.86
Semi medium (2 to 4 hectares)	10.68	30.00	11.64	32.36
Medium (4 to 10 hectares)	7.93	48.23	8.21	49.60
Large (10 hectares or more)	2.77	50.06	2.44	42.82
Total	71.01	162.13	81.52	163.14

Source: Growth and Equity: Policies And Implementation In Indian Agriculture. J.S. Sharma, Research Report 28, Internation Food Policy Research Institute.

area. The number of large holdings also declined from 2.8 to 2.4 million.

Small size, sub-division and fragmentation of holdings in India operate, both as a fact and a tendency against mechanization. Farm size is an important determinant of the kind and extent of mechanization. Because of indivisibilities, some machines like tractors can be used economically only on large holdings. In India however, the number of large holdings is small. Moreover, the farms in India - big and small, are becoming smaller with each successive

generation owing to sub-division and fragmentation of holdings. It therefore appears that the scope for mechanization in India is limited.

3. Pressure of Population:

India is traditionally associated with a very heavy pressure of population. The population to-day is 684 million and is increasing continuously at a rate of 2.2 per cent per annum. Consequently the supply of labour in agriculture seems almost unlimited. The question of technical choice in agriculture is, of fundamental importance for resource allocation and employment policy in the Indian economy. It is argued that since mechanical devices are capital intensive and labour saving, their use would aggravate rural unemployment and stand in the way of optimal resource allocation. There would be a shift in technology contrary to the resource endowment of the country and therefore be socially undesirable. Hence one of the major incentives to mechanization viz. chronic shortage of labour for agricultural operations and the need for machines to take the place of man is largely absent in India.

4. Credit Needs And Credit Institutions:

An essential pre-requisite for the success of an agricultural strategy aimed at helping the farmers is equipping the existing institutional agencies and setting up new institutions for the supply of inputs and credit. In India inadequacies of capital poses a vital problem for the introduction of new technology. The initial cost of

purchasing different inputs for introduction of improved technology is too heavy for an average Indian farmer.

Also, the spread of regular and reliable custom service of agricultural machinery in rural India is not very rapid. Therefore, unless the various financial institutions participate more actively in providing credit for purchase of agricultural implements and machinery and unless custom hiring becomes more popular, the spread of mechanization will be limited.

5. Extension Service:

Agricultural extension is responsible for bringing an innovation in agricultural technology from the laboratory to the farmer's field. The need to establish effective systems of agricultural extension has undoubtedly been increasingly recognized in India. But, unfortunately, there has been rather inadequate awareness about the nature and magnitude of the extension services available to the farmers. Further, there is almost a total lack of evidence on the impact or contribution of extension input.

6. Educational Requirements:

It is essential for the proper and effective use of machines that the farmers must be trained in mechanics. But in India there is no such thing as technical knowledge or mechanical sense among the farmers. It may therefore be said that objective conditions of education are not very favourable to the introduction of mechanical power in Indian agriculture.

Summing up, it seems that factors such as the fast growing population over a huge base of teeming millions, non-agricultural sector not growing fast to absorb the increasing multitude of unemployed workers, farms getting smaller through sub-divisions and an overall capital shortage seem to be an impediment to the process of mechanization.

These arguments, however, in many cases emerge out of an analysis of a static picture of the economy. Time dimension and the speed of change are often ignored. I.J. Singh analysing the transformation of traditional agriculture, rightly observes that technological change is task oriented. It consists of task by task replacement leading to a period of transition during which labour saving and labour using technologies continue to be juxtaposed in a 'hybrid technology', whose components depend upon the detailed cost structure of operations and whose proportions change over time.⁹

Also, the argument that farm mechanization which involves labour substitution by capital under the situation of millions of people unemployed or under-employed loses much of its validity when mechanization is visualized as a process of slow, well considered and orderly adoption of machines with all its complimentary effects on demand for

9. Johl, S.S., Mechanization, Labour Use And Productivity In Agriculture, P 3, Studies In Agricultural Capital and Technology, Occasional Paper No. 23.

other inputs, and in the process on demand for labour. Machines substitute for labour in the performance of certain farm operations, yet it enhances the capability to perform these operations more intensively and more number of times and necessitates some other operations which otherwise will not be performed. Mechanical power use may thus have some complimentary effects on labour employment at the farm level.

In view of the above, an attempt has been made in this dissertation, to review some studies on mechanization in Indian agriculture and arising out of it some arguments on the process and implications of introducing mechanical power in the agricultural sector of the Indian economy which is still in the initial stages of development.

Chapter II deals with trends in farm mechanization. In this chapter the progress achieved in two important areas of farm mechanization, viz., use of tractors and installation of diesel or electric pumps for irrigation since the end of the first five year plan is indicated.

Chapter III considers factors affecting farm mechanization. It examines the context under which biological sources of energy are becoming costlier than mechanical sources in India and also accounts for regional variation in farm mechanization.

In view of the raging unemployment in the country, one of the major objectives of planning is to build up the employment potential in different sectors. Agriculture is

the main source of employment in our pre-dominantly agrarian economy. In Chapter IV therefore, an attempt has been made, to evaluate the impact of various types of mechanization on employment and examine whether, and to what extent their impact is consistent with the national policy of building up the employment potential.

Chapter V considers the other effects of mechanization, such as its effect on draft animals and its social and economic consequences.

Chapter VI discusses the conclusions that emerge from the study. It expresses the view that adoption of unrestricted and indiscriminate mechanization, particularly in a labour-abundant economy, may adversely affect employment and equity. Indian agricultural policy therefore advocates "selective mechanization".

CHAPTER IITRENDS IN FARM MECHANIZATION : A TIME SERIES ANALYSIS

Agricultural operations in India, until recently, have been largely dependent on manually operated and animal drawn agricultural implements. Even to-day, such implements are extensively, under use, but are being gradually replaced through mechanization. In this chapter therefore, we propose to examine the incidence of mechanization in India in different years since the end of the First Five Year Plan, and its spread in different states.

Mechanization in some form and to some extent must have been there even in the very early stages of the post-independent Indian agriculture, but it is believed that over the years, particularly during the last decade, Indian agriculture has been experiencing a very rapid increase in the use of mechanical sources of energy. This phenomenon is particularly marked in the high growth pockets comprising the States of Punjab, Haryana, Western Uttar Pradesh and the deltaic belts of Tamil Nadu.

The type of technological change which Indian agriculture has been experiencing for the last decade and a half can be considered mainly as bio-chemical in nature.

However, the advent of mechanical technology of a suitable nature to go hand in hand with this new technology and its contribution in giving impetus to the new technology cannot be denied. Thus we find that since the mid-sixties there

has been a technological break-through in the country, often termed as the "Green Revolution". There have been biological innovations in the form of high yielding varieties of seeds, infra-structural changes in the nature of increased irrigation facilities and popularisation of the use of fertilizers, insecticides etc. Besides, there have also been mechanical innovations in the form of tractors, diesel engines, electric pumps and combine harvesters. Application of mechanical power to agriculture has greatly helped in promoting the efficiency of the agricultural sector.

In India, progress of farm mechanization is mainly confined to some agricultural operations by particular machines viz., (1) Tractors which are mainly used for preparatory tillage, transport and to some extent for harvesting and threshing; (2) power operated pumps (energized by oil engines or electric motors) used for lifting water for irrigation purposes. Therefore, an attempt has been made to indicate the progress achieved in only these two important areas of farm mechanization.

2.1 Sources of Power For Agricultural Operations:

Agricultural labour, bullock labour and farm machinery are the sources of power for agricultural operations. Under changing mechanical technology, one source of power might substitute another source upto a point but basic complementarity of different sources of power might remain. The available power from different sources for use in Indian

agriculture was estimated at about 40 million Horse Power (H.P.) in 1960-61 or around 0.3 H.P. per hectare, 60 per cent of this power was supplied by draught animals. The growth in available power for use in agriculture is given in Table 1.

Between 1960-61 and 1965-66, 36 per cent of the increase in power availability was contributed by oil engines and electric pumps, 14 per cent of the increase in power was due to tractors, 46 per cent due to rural labour and 3 per cent of the increase in power was made available by draught animals. Between 1965-66 and 1970-71, there was a significant change in the contribution made by different sources to the power increase that took place. During this period there was no significant growth in draught animals. 60 per cent of the increase in power availability was contributed by oil engines and electric pumps, 16 per cent by tractors, 19 per cent by rural labour and 5 per cent by draught animals.

From Table 1, it can therefore be concluded that over the years as power availability increased, the contribution made to it by mechanical devices also increased. The contribution made by draught animals has not undergone any significant change and the contribution by the rural labour force declined significantly.

Donde in his Study stated that if the entire increase of available power since 1965-66 was to be contributed by draught animals, their number ought to have been 108 million

Table 1: Estimated Power Available for Use in Agriculture

Agricultural Power: Source, No. & H.P.	1955-56	60-61	65-66	70-71
Rural Labour	123.00	131.00	153.00	169.00
H.P. (0.1)	12.3	13.10	15.30	16.90
Draught Animals	71.00	78.00	79.00	80.00
H.P. (0.3)	21.21	23.40	23.55	24.00
Oil Engines	0.12	0.23	0.45	0.90
H.P. (5.0)	0.60	1.15	2.25	4.50
Electric Pumps	0.05	0.16	0.39	1.35
H.P. (3.0)	0.15	0.48	1.17	4.05
Tractors	21.00	31.00	54.00	100.00
H.P. (30)	0.63	0.93	1.62	3.00
Total H.P. Available	34.89	39.06	43.89	52.45
Increase over the previous period		4.17	4.83	8.56
Increase contributed by electric pumps & oil engines		0.86	1.79	5.13
Increase contributed by tractors		0.30	0.69	1.38

(Nos. in millions except tractors in thousands;
H.P. in million.)

Source: Impact of Farm Mechanization On Employment-
W.B. Donde, Agricultural Situation In India,
Aug. 1971 Vol. XXVI.

or 28 million more than those in 1965-66.¹⁰ Such an increase in draught animal population would have competed with human population for land resources for raising fodder. From this point of view therefore, it is not very desirable to increase power availability by use of draught animals.

On the other hand, if the entire increase in power available in agriculture were to be contributed by rural labour since 1965-66, an addition of 85.6 million labourers over those in 1965-66 would be required. India, however, with her already 684 million people cannot afford to accept further increases in population. In fact strong policy measures are being adopted to reduce the pressure of population. Further, in the strict sense of the term substitutability, all mechanical sources of energy cannot be replaced by the human sources. There are certain operations which can hardly be carried out with any other source than mechanical.

Thus use of mechanical devices greatly help in meeting the increasing farm power which cannot be easily done with human or animal power.

2.2 Use of Tractors For Farm Operations Termed As Tractorization:

In India the farmers have increasingly realized the advantages of tractorization and hence the demand for

10. Donde, W.B., "Impact of Farm Mechanization On Employment", Agricultural Situation In India, August, 1971.

tractors over the years has been increasing. Farmers of some states have adopted tractors at a faster rate than other states. Thus the rate of adoption of tractors differs in different states. We will analyse below the adoption of tractors by farmers with main emphasis on two points:

- (i) Growth in adoption of tractors for farm operations since the end of the First Five-Year Plan in the different states of India, and
- (ii) Comparative performance of different states in the process of adoption of tractors for farm operations.

2.2.1 Growth of Tractorization In India:

Of the agricultural machinery introduced, the tractor being a versatile one has gained popularity, particularly during the last one and a half decades. The number of tractors used in India in different years during the period 1945 to 1979 for agricultural purposes is shown in Table 2.

It can be seen from Table 2 that since the beginning of the First Five Year Plan to 1979, there has been a dynamic increase in the number of tractors in India. The compound growth rate over the period 1951 to 1979 was 15.15 per cent per annum. The growth rate in the period 1951 to 1966 was 13 per cent per annum and during the period 1966 to 1979 was 17.7 per cent. This highlights the fact that in the changing structure of Indian agriculture, the tractor is emerging as an alternative source of energy to draught animal power. Also, as the farmers' desire for tractors is

Table 2

Year	Number of Tractors
1945	4,524
1951 (beginning of First Five Year Plan)	8,554
1956 (end of First Plan)	20,980
1961 (end of Second Plan)	31,016
1966 (end of Third Plan)	53,439
1969 (beginning of Fourth Plan)	71,100
1972	148,300
1977	291,831
1979 (Estimated)	444,192

Compiled from the following sources:

1. Indian Agriculture In Brief (Directorate of Economics & Statistics, Ministry of Agriculture) Eighteenth Edition.
2. Statistical Abstract of India 1972, 1977.
3. Implications of Tractorisation for Farm Employment, Productivity and Income, Volume I (NCAER) 1980.
4. Progress of Farm Mechanization In India - S.M. Patel and K.V. Patel; Seminar Series IX; ISAE.

increasing steadily, it indicates that the farmers consider such investment worthwhile.

2.2.2 Number of Tractors In Different States In India:

In Table 3 the number of tractors in different states

in India is presented.

Table 3: Number of Tractors In Different States In India

Sr. No.	States	1956	1961	1966	1969	1972	1977
1.	Andhra Pradesh	1,626	1,762	2,911	3,160	6,300	11,000
2.	Assam	159	489	834	670	500	N.A.
3.	Bihar	1,227	1,520	2,132	2,440	5,600	10,000
4.	Gujarat	1,840	2,005	3,248	4,550	7,900	15,000
5.	Karnataka	807	981	2,595	4,100	6,000	6,000
6.	Kerala	187	276	418	710	1,500	3,000
7.	Madhya Pradesh	1,311	2,025	2,113	3,100	5,000	16,000
8.	Maharashtra	1,278	1,427	3,260	4,100	5,600	12,000
9.	Orissa	95	194	667	900	1,800	N.A.
10.	Punjab (undivided)	3,809	7,866	15,489	22,340	61,100	114,831
11.	Rajasthan	1,274	3,196	4,195	5,300	11,700	24,000
12.	Tamil Nadu	822	1,387	3,278	2,880	5,000	8,000
13.	Uttar Pradesh	5,839	7,139	10,139	14,300	27,600	71,000
14.	West Bengal	450	330	1,548	2,550	700	N.A.
15.	Others*	256	419	612	N.A.	2,000	1,000
	Total	20,980	31,016	53,439	71,100	148,300	291,831

* Others refer to Union Territories and Jammu & Kashmir. Figures for Manipur, Meghalaya, Nagaland & Tripura are not available.

Source: Compiled from the following sources:

1. Indian Agriculture In Brief Eighteenth Edition.
2. Statistical Abstract of India 1961, 1966, 1977.
3. Progress of Farm Mechanization In India - S.M. Patel and K.V. Patel; Seminar Series IX ISAE.
4. Implications of Tractorisation for Farm Employment, Productivity and Income (NCAER) Volume I.

From the above table we can observe that in India, Punjab (undivided) and Uttar Pradesh possessed the largest absolute number of tractors. In 1956 Uttar Pradesh had a higher number of tractors than Punjab but after 1956 Punjab has always had the highest number of tractors.

The next group of states which had a fairly high number of tractors were Gujarat, Madhya Pradesh, Rajasthan, Andhra Pradesh, Bihar and Maharashtra. The number of tractors in Tamil Nadu has also been steadily increasing, although between 1966 and 1969, it registered an absolute decline of 398 tractors; but since then the number has again been increasing.

In the remaining states viz., West Bengal, Orissa, Kerala, Assam the absolute number of tractors is not high.

2.2.3 Compound Growth Rates In Number of Tractors for the Different States of India:

The compound growth rates in the number of tractors for the different states in India are presented in Table 4.

From Table 4 we find that the compound growth rates were higher in the period 1966-77 than in the pre-Green Revolution period in the case of all most all the states.

Over the entire period 1956-77 Punjab registered the highest growth rate of 17.6 per cent per annum in number of tractors. With the exception of others (Union Territories and J & K) the compound growth rate for each State in India ranged between 9.5 per cent and 17.6 per cent.

For India the compound growth rate over the entire

**Table 4: Compound Growth Rates In Number of Tractors
In Different States In India**

States	(Percentage per annum)		
	1956-77	1956-66 (Pre-Green Revolution)	1966-77 (Post Green Revolution)
Andhra Pradesh	9.5	5.9	12.8
Assam	N.A.	18.02	N.A.
Bihar	10.51	5.7	15.1
Gujarat	10.5	5.9	14.92
Karnataka	10.02	12.4	7.9
Kerala	14.12	8.3	19.62
Madhya Pradesh	12.65	4.9	20.20
Maharashtra	11.3	9.8	12.6
Orissa	N.A.	21.5	N.A.
Punjab (undivided)	17.6	15.05	19.9
Rajasthan	15.0	12.7	17.1
Tamil Nadu	11.44	14.83	8.4
Uttar Pradesh	12.63	5.67	19.3
West Bengal	N.A.	13.2	N.A.
Others	6.7	9.1	4.6
INDIA	13.3	9.8	16.7

Note: Calculated from Table 3 : Number of Tractors In Different States In India.

period was 13.3 per cent but in 1966-77 after the technological break-through the growth rate was 16.7 per cent per annum.

The Table reveals that over the period 1966-67 the highest growth rates were achieved in Madhya Pradesh (20.20 per cent per annum), Punjab (undivided) - 19.19 per cent per annum, Uttar Pradesh (19.3 per cent per annum) and Kerala (19.62 per cent per annum). It is observed that the absolute number of tractors in Kerala is increasing steadily. With the exception of others (Union Territories and J & K) the growth rate was not particularly low in any state.

2.2.4 Relative Share of Different States In Possession of Tractors:

An idea about the relative position of different states in tractorization could be had from Table 5. The states are divided into three groups which have been made on the basis of percentage of tractors possessed by the farmers in 1956 as compared to total tractors in India. Group I contains the highest number of tractors; Group II consists of 8 states which have a fairly large number of tractors; Group III consists of states with a low tractor population. Table 5 indicates that Group I which consists of Uttar Pradesh and Punjab possessed almost half the total number of tractors till 1969 but since then have accounted for about 60 per cent of the tractors in India. In 1956, U.P. ranked first, but since then its position was taken by

**Table 5: Relative Share Of Different States
In Possession of Tractors.**

Sr. No.	Group/ States	1956		1961		1966		1969		1972		1977	
		Rank	Per Cent	Rank	Per Cent	Rank	Per Cent	Rank	Per Cent	Rank	Per Cent	Rank	Per Cent
Group I													
1.	Uttar Pradesh	1	28	2	23	2	19	2	20	2	19	2	24
2.	Punjab	2	18	1	25	1	29	1	31	1	41	1	40
	Total		46		48		48		51		60		64
Group II													
3.	Gujarat	3	9	5	6	4	6	4	6	4	5	4	5
4.	Andhra Pradesh	4	8	4	6	7	5	7	4	5	4	6	4
5.	Bihar	5	6	7	5	9	4	8	4	6	4	8	3
6.	Madhya Pradesh	6	6	6	6	10	4	9	4	9	3	5	5
7.	Maharashtra	7	6	8	5	5	6	5	6	7	4	7	4
8.	Rajasthan	8	6	3	10	3	8	3	8	3	8	3	8
	Total		41		38		33		32		28		29
Group III													
9.	Tamil Nadu	9	4	9	5	6	6	10	4	10	3	9	3
10.	Kerala	10	4	10	3	8	5	6	6	8	4	10	2
11.	West Bengal	11	2	12	1	11	3	11	4	11	1	-	-
12.	Assam	12	1	11	2	12	2	12	1	12	1	-	-
13.	Kerala	13	1	13	1	13	1	13	1	13	1	11	1
14.	Orissa	15	Neg	15	1	15	1	14	1	14	1	-	-
15.	Others	14	1	14	1	14	1	15	N.A.	15	1	12	1
	Total		13		14		19		17		12		7
	All India Total		100		100		100		100				100

Note: Neg - Negligible.
Calculated from Table 3.

Punjab. The data available reveal that their share is constantly increasing.

The next group of states accounted for 41 per cent of the tractors in 1956 but over the years their share is continuously declining. Rajasthan ranked eighth in 1956, but since then it has always ranked third.

The third Group of states which had a very low tractor population improved their position in 1966 and 1969 compare to their position earlier but again in 1972 their share dropped to 12 per cent. In Group III the ranking has remained fairly stable over the years.

2.2.5 Relative Importance Of Different States In Possession of Tractors per 1,000 Heatares:

Due to different sizes of the states and the differences in their area to be served by tractors, the percentage share in the number of tractors does not reflect the real competitive position of different states. For such comparisons the absolute number of tractors is reduced to the common norm of the number of tractors per 1,000 hectares of net cultivated area. This has been presented in Table 6. The data presented in Table 6 indicate that till 1969 (beginning of the Fourth Five Year Plan) there was not even one tractor per 1,000 hectares of net sown area for India as a whole. From among the individual states also, only Punjab had more than one tractor per 1,000 hectares of net sown area since 1961, U.P. had more than one tractor since 1972. It is only since 1977 that most states in India had

Table 6: Relative Importance Of Different States In Possession Of Tractors Per 1,000 Hectares

Sr. No.	Group/ States	1956		1961		1966		1969		1972		1977	
		Rank	Tractor per 1000 hec.	Rank	Tractor per 1000 hec.	Rank	Tractor per 1000 hec.	Rank	Tractor per 1000 hec.	Rank	Tractor per 1000 hec.	Rank	Tractor per 1000 hec.
Group I													
1.	Punjab	1	0.51	1	1.05	1	2.09	1	2.74	1	7.45	1	13.73
2.	Uttar Pradesh	2	0.34	2	0.41	2	0.58	2	0.82	2	1.61	2	2.03
Group II													
3.	Others	3	0.18	3	0.29	4	0.37	N.A.	N.A.	10	.83		
4.	Andhra Pradesh	4	0.15	7	0.16	9	0.26	11	0.27	9	0.56	8	1.04
5.	Bihar	5	0.15	8	0.18	10	0.26	10	0.29	6	0.70	7	1.19
6.	Tamil Nadu	6	0.14	4	0.23	3	0.55	3	0.47	4	0.79	6	1.33
7.	Gujarat	7	0.11	6	0.21	6	0.34	4	0.47	3	0.87	4	1.56
8.	Maharashtra	8	0.11	12	0.08	13	0.18	12	0.22	10	0.35	11	0.66
9.	Rajasthan	9	0.10	5	0.23	7	0.30	6	0.40	5	0.78	3	1.59
10.	Kerala	10	0.10	9	0.14	12	0.20	8	0.32	7	0.68	5	1.36
Group III													
11.	West Bengal	11	0.09	13	0.06	8	0.28	5	0.45	14	0.12		N.A.
12.	Karnataka	12	0.08	11	0.10	11	0.26	7	0.40	8	0.61	12	0.65
13.	Madhya Pradesh	13	0.08	10	0.13	14	0.15	14	0.16	12	0.27	9	0.86
14.	Assam	14	0.07	15	0.02	5	0.36	9	0.30	13	0.21		N.A.
15.	Orissa	15	0.02	14	0.03	15	0.11	13	0.14	11	0.32		N.A.
	Overall		0.16		0.23		0.34		0.51		1.08		2.08

Source: Indian Agriculture In Brief, 12th, 17th, 18th Editions, for Net Sown Area Statistical Abstract of India, 1951, 1966, 1972.

more than one tractor per 1,000 hectares of net sown area.

Looking at the relative position of the states, we find that Punjab and U.P. have maintained their top ranks over the years. In 1956, Maharashtra belonged to Group II but in subsequent years lost its position and fell to the third group.

The simultaneous reading of Table 5 and 6 lead to the following observations:

- (1) Punjab and U.P. topped the list of all the states in the possession of tractors either in absolute figures or in their relative position of the number of tractors per 1,000 hectares of net sown area over the entire period.
- (2) Gujarat, Bihar and Rajasthan maintained their middle position in both respects while Andhra Pradesh lost its position from Group II in respect of number of tractors per 1,000 hectares in 1969. In 1972, however, Andhra Pradesh regained its earlier position and fell into Group II.
- (3) Although the absolute number of tractors in Madhya Pradesh is fairly high and increasing over the years, it falls in Group III with respect to number of tractors per 1,000 hectares. In 1977 however it ranked ninth in this respect.
- (4) Kerala and Tamil Nadu belonged to Group III in their relative share in the number of tractors as compared to the total number of tractors in India. With

reference to number of tractors per 1,000 hectares, however, they belonged to Group II. Also, the absolute number of tractors in these two states has been increasing steadily.

- (5) Orissa remained the lowest according to both the norms.
- (6) West Bengal belonged to Group III in both respects till 1961. But in the years 1966 and 1969 it came up in Group II with respect to number of tractors per 1,000 hectares of net sown area.
- (7) Assam belonged to Group III in its relative share in number of tractors as compared to total number of tractors in India. In 1966 and 1969 it improved its rank and came up to Group II with respect to number of tractors per 1,000 hectares. But in 1972 its position deteriorated again and it fell into Group III.

2.2.6 Distribution of Tractor Population By Horse-Power:

Table 7 gives the distribution of tractors by horse-power.

The table indicates that between 1975-79 tractors belonging to 20-29 and 30-39 H.P. range were 75 per cent. Around 15 per cent to 20 per cent of tractors were in the range of 40-49 H.P. and only a very small percentage of tractors had H.P. above 50.

Tractors with small H.P. range are preferred where the size of holdings is small (which is common in India). Where the holdings are large like Uttar Pradesh (Terai area) the farmers understandably prefer large H.P. tractors.

Table 7: Distribution of Tractors by Horse Power

Year	20-29 HP	30-39 HP	40-49 HP	50 & above HP	Total
1975	31.0	45.5	19.6	3.9	100.0
1976	19.0	57.0	18.7	4.4	100.0
1977	30.5	47.4	15.9	6.2	100.0
1978	26.3	51.0	15.4	7.3	100.0
1979	27.7	50.9	16.8	4.6	100.0

Source: Implications of Tractorisation for Farm Employment, Productivity and Income Volume I NCAER (1980).

2.3 Mechanization of Lift Irrigation In India:

Expansion of lift irrigation has been one of the most important factors in the strategy for development of agriculture in India since the beginning of the planning process. Therefore over the years and during the last two decades in particular, most of the traditional bullock-drawn or manually operated water lifts have been replaced by diesel or electric engine operated pumpsets. Thus the number of irrigation pumpsets has been increasing considerably over the years.

In this section an attempt has been made to analyse the progress of mechanized lift irrigation with particular emphasis on:

- (i) progress in installation of power operated pumps in different states of India;
- (ii) relative share of electrified and dieselized pumps

- in total power operated pumps in different rates of India over a specific time horizon;
- (iii) comparative position of different states with respect to installation of power operated pumps at different points of time.

2.3.1 Number of Power Operated Pumps (Diesel and Electric) In Different States of India:

Data on the number of diesel pumpsets installed for irrigation during the last 8-9 years are not readily available. Firm official figures for the total number of diesel pumpsets in use for irrigation in different states are available on a quinquennial basis from the livestock census. The latest census year for which the data are available is 1972.¹¹ In the case of number of electric pumpsets however, figures are available till 1978. This information is published by the Rural Electrification Corporation.

In Table 8 the Number of Power Operated Pumpsets (Diesel and Electric) till 1972 are presented.

From Table 8 it is observed that in 1956 the number of power operated pumpsets was 168,441. Their number rose to 32,44,000 in 1972, i.e. about 19 times more in 16 years.

Tamil Nadu possessed the largest number of irrigation pumpsets over the entire period. Maharashtra too had a high number of pumpsets compared to the rest of the States in India till 1966. In 1972, however, the number increased rapidly in Punjab, Gujarat and Uttar Pradesh.

11. Data from 1977 Livestock Census are not yet available.

Table 8: Number Of Power Operated Pumps (Diesel & Electric) In Different States Of India

Sr. No.	States	1950			1961			1960			1972		
		Diesel	Electric	Total	Diesel	Electric	Total	Diesel	Electric	Total	Diesel	Electric	Total
1.	Andhra P.	16,771	3,220	19,991	33,940	17,024	50,964	46,741	57,225	103,966	117,000	145,000	262,000
2.	Assam	55	302	357	76	51	127	362	22	384	500	500	1,000
3.	Bihar	2,904	749	3,653	3,187	1,930	5,117	3,698	6,854	10,552	40,000	53,000	93,000
4.	Gujarat	19,270	1,140	20,410	44,992	6,229	51,221	112,428	14,729	127,157	371,000	48,000	419,000
5.	Karnataka	5,628	3,481	9,109	10,087	12,433	22,520	24,575	27,054	51,629	43,000	159,000	202,000
6.	Kerala	2,504	735	3,239	3,572	2,565	6,137	6,824	4,869	11,693	19,000	10,000	29,000
7.	Madhya P.	5,464	276	5,740	9,681	2,228	11,909	16,511	6,116	22,627	64,000	60,000	124,000
8.	Maharashtra	26,715	2,108	28,823	63,747	6,530	70,277	146,126	37,741	183,867	174,000	170,000	344,000
9.	Orissa	886	70	956	1,203	129	1,332	710	189	899	6,000	500	6,500
10.	Punjab (undiv.)	5,057	6,839	11,896	8,164	7,770	15,934	11,827	21,032	32,859	302,500	144,500	447,000
11.	Rajasthan	1,317	342	1,659	2,434	477	2,911	7,252	4,954	12,206	37,000	36,000	73,000
12.	Tamil Nadu	27,761	23,962	51,723	36,832	98,481	135,313	42,852	208,485	251,337	234,000	681,000	915,000
13.	Uttar Pradesh	4,321	1,693	6,014	8,408	2,919	11,327	28,146	10,197	38,343	206,000	106,000	312,000
14.	West Bengal	1,397	97	1,494	3,637	256	3,893	4,162	629	4,791	5,000	2,000	7,000
15.	Others*	N.A.	N.A.	N.A.	181	90	271	579	2,817	3,396	3,000	6,500	9,500
India Total		121,511	46,930	168,441	230,141	159,112	389,253	452,793	402,913	855,706	1622,000	1622,000	3244,000

Others* - Includes Union Territories, J.& K., Manipur, Meghalaya, Nagaland, Tripura.

Note: The total figures for India are the addition of all the States and hence may be slightly different from that available in various sources.

Compiled from the following Sources:

- (1) Indian Agriculture In Brief, 13th Edition, 18th Edition.
- (2) Indian Livestock Census 1972.
- (3) Statistical Abstract of India 1961, 1968, 1977.
- (4) Farm Machinery Directory; Indian Society of Agricultural Engineers.

The States which have a low absolute number of irrigation pumpsets are Assam, Orissa and West Bengal. These states are far behind the other states in India with respect to absolute number of irrigation pumpsets.

2.3.2 Compound Growth Rates In Number Of Power Operated Pumps (Diesel & Electric) In Different States Of India:

In Table 9 the compound growth rates for power operated pumps are presented.

Over the entire period 1956-72, the highest growth rate in total pumps was achieved by Uttar Pradesh (27.99 per cent per annum) followed by Rajasthan and Punjab. For India the compound growth rate was 20.31 per cent per annum.

Regarding electric pumps during 1956-72 the highest growth rate was registered in Madhya Pradesh, followed by Rajasthan, Maharashtra and Bihar respectively.

With the exception of Assam where the growth rate for electric pumps was 3.2 per cent per annum the rate of growth for other States in India was not particularly low. For Orissa it was 13.08 per cent per annum and for other states it ranged between 20.82 per cent and 39.98 per cent per annum.

With respect to diesel pumps the growth rate in West Bengal was the lowest, - 8.30 per cent per annum. For the other states it ranged between 10.49 per cent per annum (Uttar Pradesh) and 29.14 per cent per annum (Punjab undivided).

During the period 1956-66 or prior to the Green Revo-

**Table 9: Compound Growth Rates In Number Of Power Operated Pumps
(Diesel & Electric) In Different States Of India**

Sr. No.	State	Percentage per annum								
		1956-72			1956-66			1966-72		
		Diesel	Electric	Total	Diesel	Electric	Total	Diesel	Electric	Total
1.	Andhra Pradesh	12.9	26.87	17.4	13.8	33.3	18.0	16.5	16.8	16.6
2.	Assam	14.8	3.2	6.7	20.7	-23.04	0.7	5.7	68.30	17.2
3.	Bihar	17.8	30.5	22.0	2.4	24.78	11.19	48.71	40.62	43.72
4.	Gujarat	20.30	26.33	20.79	19.29	29.16	20.07	22.02	21.76	21.99
5.	Karnataka	13.55	26.98	21.37	15.88	22.76	18.94	9.77	34.34	25.53
6.	Kerala	13.50	17.72	14.68	10.55	20.81	13.70	18.61	12.74	16.34
7.	Madhya Pradesh	16.63	39.98	21.17	11.69	36.32	14.70	25.33	46.31	32.78
8.	Maharashtra	12.42	31.57	16.76	18.52	33.44	20.36	2.95	28.51	11.00
9.	Orissa	12.70	13.08	12.73	-2.2	10.44	- .006	42.72	17.60	39.06
10.	Punjab (undivided)	29.14	21.01	25.44	8.87	11.89	10.69	71.65	37.88	54.50
11.	Rajasthan	23.18	33.78	26.68	18.60	30.65	22.09	31.21	39.17	34.73
12.	Tamil Nadu	14.25	23.27	19.67	4.44	24.15	17.13	32.70	21.81	24.03
13.	Uttar Pradesh	10.49	29.51	27.99	20.61	19.67	20.35	39.34	47.73	41.82
14.	West Bengal	8.30	20.82	10.13	11.53	20.56	12.36	3.10	21.26	6.52
15.	Others	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	31.54	14.95	18.70
	India	17.58	24.79	20.31	14.06	23.99	17.65	23.17	26.13	24.87

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Note: Calculated from Table 8 : Number Of Power Operated Pumps (Diesel & Electric)
In Different States Of India.

Revolution, the annual rate of growth in total number of pumps for India was 17.65 per cent, for diesel 14.06 per cent and electric 24 per cent. In this period a growth rate of -0.006 per annum was observed in Orissa. This was chiefly due to a negative growth rate in diesel pumps. Assam registered a negative growth rate with respect to electric pumps but for total pumps the growth rate was 0.7 per cent per annum; this was apparently due to considerable rise in number of diesel pumps.

With the advent of new technology in the agricultural sector of the economy, in 1966, the number of pumps began to increase rapidly. Electric pumps registered a growth rate of 26.13 per cent per annum over the period 1966-72 and diesel pumps a growth rate of 23.17 per cent per annum in India. In case of total pumps the highest growth rate was observed in Punjab (54.50 per cent per annum) and the lowest in Bengal (6.52 per cent per annum). For most states fairly higher growth rates were achieved in the period 1966-72 than in the period 1956-66. This could possibly be because development of irrigation is a precondition for advanced agricultural technology and its provision extends the productive use of inputs including labour and increases output per unit of land. The demand for the installation of diesel engines or electrically operated pumps for purposes of irrigation is therefore rising rapidly and the growth rates are registering rather high increases in some of the states in India. In Tamil

Nadu which possesses the highest number of pumpsets in India the growth rate during the period 1966-72 was 24.03 per cent per annum. States such as West Bengal did not progress much during this period.

2.3.3 Share Of Diesel And Electric Pumps In Total Number Of Irrigated Pumpsets In Different States:

This is presented in Table 10.

Table 10 indicates that the share of electrified pumps which was 27.87 per cent in 1956 has increased to 50 per cent in 1972. Thus its share has risen from a little more than 1/4th to 1/2. This kind of steady progress was also realized by states like Andhra Pradesh, Kerala, Madhya Pradesh, Karnataka and Uttar Pradesh. At the end of the First Plan (1956) only Assam and Punjab had more than 50 per cent of their total pumps operated by electric motors while 5 states viz. Gujarat, Madhya Pradesh, Maharashtra, Orissa, West Bengal had even less than 10 per cent of the total pumps operated by electric motors. In 1972 however there was a radical change in the share of diesel and electric pumps in total number of Irrigation Pumpsets. Andhra Pradesh, Assam, Bihar, Madhya Pradesh, Maharashtra and Rajasthan had about 50 per cent of their pumpsets operated by electric motors; Karnataka and Tamil Nadu had about 3/4th of the irrigation pumpsets operated by electric motors and Kerala, Punjab and Uttar Pradesh had 1/3rd of their pumpsets electrically operated.

It therefore appears that irrigation pumpsets operated

Table 10: Share Of Diesel And Electric Pumps In Total Number Of Irrigation Pumpsets In Different States

Sr. No.	States	(Percentages)							
		1956		1961		1966		1972	
		Diesel	Electric	Diesel	Electric	Diesel	Electric	Diesel	Electric
1.	Anahre Pradesh	83.89	10.11	66.60	33.40	44.96	55.04	44.66	55.34
2.	Assam	15.41	84.59	59.84	40.16	94.27	5.73	50.00	50.00
3.	Bihar	79.50	20.50	62.28	37.72	35.05	64.95	43.01	56.99
4.	Gujarat	94.41	5.59	87.84	12.16	88.42	11.58	88.54	11.46
5.	Karnataka	61.79	38.21	44.79	55.21	47.60	52.40	21.29	78.71
6.	Kerala	77.31	22.69	58.20	41.80	58.36	41.64	65.52	34.48
7.	Madhya Pradesh	95.19	4.81	81.29	18.71	72.97	27.03	51.61	48.39
8.	Maharashtra	92.69	7.31	90.71	9.29	79.47	20.53	50.58	49.42
9.	Orissa	92.68	7.32	90.32	9.68	78.98	21.02	92.31	7.69
10.	Punjab (undivided)	42.51	57.49	51.24	48.76	35.99	64.01	67.67	32.33
11.	Rajasthan	79.39	20.61	83.61	16.39	59.41	40.59	50.68	49.32
12.	Tamil Nadu	53.67	46.33	27.22	72.78	17.05	82.95	25.57	74.43
13.	Uttar Pradesh	71.85	28.15	74.23	25.77	73.41	26.59	66.03	33.97
14.	West Bengal	93.50	6.50	93.42	6.58	86.87	13.13	71.43	28.57
15.	Others	N.A.	N.A.	66.79	33.21	17.04	82.96	31.58	68.42
	India	72.13	27.87	58.59	41.41	52.91	47.09	50.00	50.00

by electric motors are gaining importance over time and among the two types of power operated pumps, farmers generally prefer electrified pumps to dieselized pumps. This could perhaps be due to the fact that electric pumpsets are less expensive than diesel pumpsets and the cost of electricity is less compared to that of diesel oil. Further, in the recent past there have been frequent upward revisions in the diesel oil prices and this trend is likely to continue. This enables one to conclude that if rural electrification spreads rapidly so that more and more villages become electrified, and finance to buy electric motors to replace the diesel engines is readily available, there will be large-scale shifts to electrified pumps. In fact, a survey conducted by the ARDC in the Punjab showed that in recent years there has been a steady substitution of diesel pumpsets by electric ones.¹² It must however be remembered that this switchover is possible only if there is no deficit in power availability and no shortage of material particularly aluminium, for the State Electricity Boards to provide power connections to farms.

In non-electrified villages the farmers do not have any other choice but to expand lift irrigation facilities with the help of diesel engines operated pumps and therefore until rural electrification takes place energisation of pumpsets by diesel will continue to take place.

12. Agricultural Refinance And Development Corporation, Report of The Committee To Estimate the Demand for pumpsets During 1978-83 and Study The Policy and Procedure of Financing it, p.11, Bombay, 1979.

2.3.4 Number of Electrically Operated Irrigation Pumpsets In India During 1974-78:

In Table 11 number of electrically operated pumpsets are shown for the period 1974-78. We do not have data on diesel pumpsets for the years 1974-78 and hence cannot compare the share of diesel and electric pumpsets in the different states during this period. However, from Table 11 it is observed that the number of electric pumpsets is continuously increasing in all the states. The highest number of electric pumpsets were in Tamil Nadu over the entire period. Maharashtra, Gujarat, Punjab and Andhra Pradesh also have a high number of pumpsets. In fact in most states the number is fairly high and is rising over the years.

In Table 11 the compound growth rates in number of electric pumpsets (1974-78) is also presented. The highest growth rate was in West Bengal (32.83 per cent per annum), followed by Orissa (23.54 per cent per annum) which indicates that States which are lagging behind are gradually improving their position.

Table 11: Number Of Electrically Operated Irrigation Pumpsets
In India During 1974-78

Sr. No.	State	1974	1975	1976	1977	1978	Compound Growth Rate (1974-78) (per cent per annum)
1.	Andhra Pradesh	261,989	275,732	294,017	306,795	337,546	6.5
2.	Assam	705	776	1,012	1,054	1,054	10.6
3.	Bihar	96,922	104,034	118,055	132,322	139,982	9.6
4.	Gujarat	102,683	113,723	121,854	137,916	156,028	11.0
5.	Karnataka	189,688	207,667	224,910	242,471	262,362	8.44
6.	Kerala	37,661	41,549	47,525	53,148	58,922	11.84
7.	Madhya Pradesh	115,560	133,295	146,739	180,282	215,927	16.92
8.	Maharashtra	342,265	380,444	412,068	448,796	488,706	9.31
9.	Orissa	2,759	3,490	4,524	5,428	6,427	23.54
10.	Punjab (undiv.)	258,545	275,057	289,680	322,909	364,643	8.98
11.	Rajasthan	74,696	86,793	93,826	108,080	128,961	14.62
12.	Tamil Nadu	681,205	706,914	742,746	780,816	809,606	4.41
13.	Uttar Pradesh	233,640	249,480	260,738	273,025	298,750	6.33
14.	West Bengal	6,535	7,694	10,701	17,132	20,346	32.83
15.	Others	13,952	15,272	17,478	18,989	19,988	9.4
	Total	2418805	2602320	2785873	3029163	3309246	8.15

Others: Union Territories, J.& K., Meghalaya, Manipur, Nagaland, Tripura.

Source: Report of the Committee To Estimate The Demand For Pumpsets During 1978-83 And Study The Policy And The Policy And Procedure Of Financing It, p 19, Bombay, 1979.

Note: Compound Growth Rates are calculated from the figures available in Table 11 itself.

2.3.5 Relative Rank of States In Possession of Power Operated Pumps of Both Types:

Table 12 gives us the relative rank of states in possession of power operated pumps of both Types. It is evident from the data given in Table 12 that Tamil Nadu has the highest percentage of pumpsets among all states in India and ranks first in this respect. Next in rank is Maharashtra followed by Gujarat and Andhra Pradesh. These four states together claimed about 75 per cent of the total pumps in the whole country upto the end of the Third Five Year Plan. In 1972 however, the share of Andhra Pradesh was only 8.0 per cent and it ranked sixth in the country.

The next group of states viz. Punjab (undivided), Karnataka, Uttar Pradesh and Madhya Pradesh claimed about 20 per cent of the total pumpsets in 1956 but in 1972 their share increased to 33.45 per cent and Punjab had the second highest number of pumpsets in India.

The remaining states which belonged to Group III had a very low share in the total number of pumpsets. In India, Assam had the lowest percentage of power operated pumpsets. In fact over the entire period 1956-72 Orissa and Assam had less than 1 per cent of the total pumpsets.

Thus on the one hand it is observed that there were states such as Tamil Nadu which had a high percentage of the total pumpsets and on the other hand there were States such as Assam and Orissa which lagged very much behind. This indicates that there are considerable disparities in

Table 12: Relative Rank of States In Possession Of
Power Operated Pumps Of Both Types

	1956		1961		1966		1972	
	Rank	per cent	Rank	Per cent	Rank	Per cent	Rank	Per cent
<u>Group I</u>								
Tamil Nadu	1	30.71	1	34.76	1	29.37	1	28.21
Maharashtra	2	17.11	2	18.05	2	21.49	4	10.60
Gujarat	3	12.12	3	13.15	3	14.86	3	12.92
Andhra Pradesh	4	11.86	4	13.09	4	12.15	6	8.07
		<u>71.80</u>		<u>79.05</u>		<u>77.87</u>		<u>59.80</u>
<u>Group II</u>								
Punjab (undiv.)	5	7.06	6	4.09	7	3.84	2	13.78
Karnataka	6	5.41	5	5.79	5	6.03	7	6.23
Uttar Pradesh	7	3.57	8	2.91	6	4.48	5	9.62
Madhya Pradesh	8	3.41	7	3.06	8	2.64	8	3.82
		<u>19.45</u>		<u>15.85</u>		<u>16.99</u>		<u>33.45</u>
<u>Group III</u>								
Bihar	9	2.17	10	1.31	11	1.23	9	2.87
Kerala	10	1.93	9	1.58	10	1.37	11	0.89
West Bengal	11	0.89	11	1.00	12	0.55	14	0.22
Rajasthan	12	0.98	12	0.75	9	1.43	10	2.25
Orissa	13	0.57	13	0.34	14	0.11	13	0.20
Assam	14	0.21	15	0.05	15	0.05	15	0.03
Others		N.A.	14	0.07	13	0.40	12	0.29
		<u>6.75</u>		<u>5.10</u>		<u>5.14</u>		<u>6.75</u>

Calculated from Table 8.

the possession of irrigation pumpsets among the various States in India.

2.3.6 Comparative Position Of Different States With Respect To The Number Of Power Operated Pumps Per 1,000 Hectares Of Net Sown Area:

In view of the difference in sizes and the area to be served by the power operated pumps in different states it would not be perfectly correct to form an opinion about comparative stages of technological advancement attained by different states merely on their basis of their percentage share of total number of pumps in the whole country.

It is therefore better to speak of the stage of technological advancement of a particular state only after comparing the number of pumps installed by its farmers against the background of the Net Sown Area to be served by the pumps in that State. The relevant information about this aspect is given in Table 13.

From Table 13 it can be seen that Tamil Nadu apart from possessing the highest number of pumpsets in the country also enjoyed the first position with respect to the number of pumps per 1,000 hectares. In 1956 it had 8.86 power operated pumps per 1,000 hectares and in 1972 it had 144.50 pumps per 1,000 hectares. This shows that over time there has been a dynamic increase in irrigation pumpsets in Tamil Nadu.

The Gujarat State consistently enjoyed the second position except in 1972 when it ranked third and its position was taken by Punjab.

Table 13: Comparative Position Of Different States With Respect To The Number Of Power Operated Pumps Per 1,000 Hectares Of Net Sown Area.

States	1956		1961		1966		1972	
	Rank	No. of Pumps/1000 hec.	Rank	No. of Pumps/1000 hec.	Rank	No. of Pumps/1000 hec.	Rank	No. of Pumps/1000 hec.
<u>Group I</u>								
Tamil Nadu	1	8.86	1	22.56	1	41.30	1	144.50
<u>Group II</u>								
Gujarat	2	2.17	2	5.45	2	13.12	3	46.24
Andhra Pradesh	3	1.76	3	4.72	4	9.17	4	23.65
Kerala	4	1.76	5	3.19	5	5.59	8	13.20
Punjab	5	1.62	7	2.15	7	4.51	2	54.51
Maharashtra	6	1.60	4	3.93	3	10.14	5	21.42
<u>Group III</u>								
Karnataka	7	0.89	6	2.20	6	5.16	6	20.60
Bihar	8	0.47	11	0.64	10	1.42	9	11.55
Uttar Pradesh	9	0.36	10	0.66	9	2.21	7	18.15
Madhya Pradesh	10	0.36	8	0.74	11	1.32	10	6.70
West Bengal	11	0.29	9	0.72	12	0.86	13	1.23
Assam	12	0.17	15	0.06	14	0.16	15	0.42
Orissa	13	0.17	13	0.24	15	0.15	14	1.16
Rajasthan	14	0.13	14	0.22	13	0.84	12	4.91
Others	15	N.A.	12	0.36	8	2.83	11	5.30
India		1.29		2.93		6.24		23.72

Note: Figures for Net Sown Area Were Obtained From Statistical Abstract Of India, 1961, 1965, 1969, 1972.

Kerala which belonged to Group III and Uttar Pradesh which belonged to Group II in possession of total number of pumps inter-changed their positions with respect to their possession of pumps per 1,000 hectares. Bihar, Orissa, Rajasthan, Assam and West Bengal were the States which had a low rank in possession of power operated pumps both in absolute terms as well as in pumps per 1,000 hectares.

The overall picture for the Indian Economy is however quite good. In 1956 it had 1.2 pumps per 1,000 hectares out in 1972 considerably improved its position to 23.74 pumps. This shows that there has been a remarkable technological progress in the country.

CHAPTER IIIFACTORS AFFECTING FARM MECHANIZATION

India is entering into an era of progressively increased mechanization of agriculture. Notable strides have been made in farm mechanization, in the past decade, as is evident, from an account of the trends in mechanization presented in Chapter II. The Indian farmer, used to his traditional tools and implements has taken on to tractors and more sophisticated machinery only in recent years. The growth of mechanization, however, varies widely in different states of the country. In general, farmers in selected states of the northern, western and southern regions of the country have been the largest adopters. In the use of lift irrigation machinery, Tamil Nadu leads the rest of the states while in the use of tractors and allied machinery for agricultural operations, Punjab is in the forefront.

Farm mechanization is of recent origin in the country and consequently, only a limited number of studies of this nature have so far been made. In what follows an attempt has been made, to examine the factors which affect farm mechanization in India, as revealed by certain studies.

3.1 The conditions Under Which Mechanization Is Taking Place In India:

Hanumantha Rao¹³ in his study explains that, farmers

13. Hanumantha Rao, C.H., Technological Change & Distribution Of Gains In Indian Agriculture, Institute of Economic Growth, The Macmillan Company Of India Limited, Delhi, 1980.

in developed as well as developing economies resort to mechanization of farm operations when the biological sources of energy become costlier than the mechanical sources. However, the conditions under which the biological sources of energy become costlier than mechanical sources in India are different from that in the developed countries. On the one hand, population has been growing at a significant rate resulting in an increase in the supply of labour for the agricultural sector and the growth in per capita income has been negligible, particularly after the mid-sixties. On the other hand however, we find that the rate of farm mechanization has accelerated since the mid-sixties. The puzzle then is : How does the cost of biological sources of energy increase relative to that of the mechanical sources when unemployment and underemployment is growing in the economy and when growth in per capita income is negligible? Why do the relative factor prices move against biological sources of energy despite the growth in the supply of labour? The reason for such a tendency to occur is that the population explosion increases the supply of labour as well as generates an increasing demand for foodgrains and agricultural commodities. If one considers exclusively the increasing supply of labour as a result of population growth, one is confronted with the above puzzle, because it appears reasonable to believe that when the labour force increases, wages should come down and consequently it should become

more profitable to adopt labour-intensive techniques of production in preference to capital-intensive or mechanized techniques. But, if one focuses on the implications of the rising demand for agricultural commodities as a result of population growth, one finds clues to resolving this puzzle.

As the prices of foodgrains rise, consequent on the growth of population, the money value of wages paid in kind (which are substantial in Indian agriculture) automatically rises. Even cash wages may not lag behind prices very much, because they are already at subsistence level and so a significant fall in real wages would be strongly resisted. These factors are hidden from view if one focuses only on the supply of labour in terms of growth in numbers. Labour in the sense of effective energy or efficiency units cannot be abundant when food is in short supply and the cost of labour can rise despite, and indeed owing to, the growth of population.

Apart from the rise in money wages, the cost of human labour may have increased on two other counts. In the first place, the rise in price of agricultural commodities might have induced the extension of cultivation to the less productive or marginal land, requiring harder and more labour per unit of output. Secondly, the possible decline in per capita consumption by labourers, especially in the sixties, perhaps owing to the decline of real wages, might have reduced their efficiency.

Owing to the prevailing unequal distribution of land, the cost of draft power per acre is higher among the large farms than would be the case if land were more equally distributed. This is because, unlike for a small farmer, who contributes own labour on the farm, labour forms paid-out cost for a large farmer. The real cost of draft power for large farms is higher still, owing to managerial and supervisory costs which may increase steeply with the increase in the size of the holding under labour intensive techniques. Moreover, with the expansion of output, the uncertainty in regard to the availability of required labour for crucial operations such as ploughing raises the anticipated or ex ante costs for the large farmers. Small farmers, of say 5 or 10 acres, owing to the availability of sufficient labour from their own families, can keep to the time schedule by making up the time lost because of adverse weather when it delays ploughing. The large farmers, on the other hand, may need tractors for ensuring timeliness of operations and to insure against the uncertainties of hired labour. Therefore, in the context of expanding agricultural output, large farmers may find mechanical sources less costly and hence resort to mechanization of farm operations.

3.1.1 Changes In Product And Factor Prices: Prices of Agricultural Commodities:

Population pressure in India has been one of the chief factors accounting for the steep rise in prices of agricultural commodities, despite the technical progress that has

taken place or is still underway in agriculture. In the course of less than a decade since 1961-62, prices of agricultural commodities - especially of foodgrains - doubled. This can be seen from Table 14.

Table 14: Price Indices of Agricultural Commodities
In India (1961-62 = 100)

<u>Price Indices</u>		
<u>Year</u>	<u>Foodgrains</u>	<u>Agricultural Commodities</u>
1962-63	105.4	102.3
1963-64	115.2	108.4
1964-65	145.5	130.9
1965-66	154.3	141.7
1966-67	182.9	166.6
1967-68	228.4	188.2
1968-69	201.0	179.4
1969-70	208.2	194.8
1970-71	206.2	201.0
1971-72	214.9	199.6

Source: Reserve Bank of India Bulletin, Jan. 1970
Reserve Bank of India Bulletin, Sept. 1972.

The prices of foodgrains rose significantly and reached their peak by 1967-68. The prices however showed a gradual decline in the subsequent period, when the Green Revolution resulted in a steady increase in agricultural output. But despite the softening impact of the technological change, the price index in 1971-72 showed a fairly

high upward revision as compared to the previous three years.

The persistence of higher relative prices over a long period suggests the cost of production of agricultural commodities may have risen during this period. Indeed, the rising cost may have provided incentives for technological changes, in the absence of which the prices of agricultural commodities would have been higher still.

Relative Prices of Traditional And Modern Inputs:

Despite the weaker bargaining power of agricultural labour, the money wages of plougher/field labour rose by not less than 50 per cent during 1961-62 to 1969-70. In about half the number of states, money wages rose roughly in proportion to the rise in prices of agricultural commodities. The changes in agricultural wage rate can be seen from Table 15.

Thus Hanumantha Rao's contention that rising prices of foodgrains which cause wage rates also to rise is borne out by the data on these two variables presented in Tables 14 and 15.

While considering the biological sources of energy, one must also give weight to animal labour. In Indian agriculture, it appears from the growth of draught animal population in the last two censuses that the fodder resources are exercising a constraint on the growth of draught animal population. Prices of draught animals have doubled in the last ten years and are rising as the demand for

Table 15: Changes In Agricultural Wage Rate

State	Agricultural Operation	Wage Rate (Rs. per day) 1961-62	Wage Rate (Rs. per day) 1969-70	Per cent change
Punjab	Plougher	2.81	6.34	125.6
Kerala	Field labourer	2.10	4.67	122.4
Bihar	Plougher	1.33	2.70	103.0
Uttar Pradesh	Plougher	1.31	2.61	99.2
Maharashtra	Field labourer	1.48	2.85	92.6
Tamil Nadu	Plougher	1.43	2.65	85.3
Orissa	Field labourer	1.26	2.15	70.6
West Bengal	Field labourer	1.85	3.17	71.4
Andhra Pradesh	Field labourer	1.46	2.46	68.5
Assam	Field labourer	2.29	3.80	65.9
Madhya Pradesh	Plougher	1.32	2.11	59.8
Gujarat	Field labourer	1.97	2.94	49.2
Karnataka	Field labourer	1.64	2.35	43.3

Source: Technological change And Distribution of Gains
In Indian Agriculture - C.H. Hanumantha Rao pg 31.

power for agricultural requirements is increasing due to expansion of irrigation, multiple cropping and adoption of HYV's.¹⁴ The rise in price of bullocks in Punjab can be seen from Table 16.

14. Donde, W.B., "Impact of Farm Mechanization On Employment", Agricultural Situation In India, August 1971.

Table 16: Bullock Prices In Punjab (for class I Bullock)

<u>Year</u>	<u>Price (Rs.)</u>	<u>Index (1961 = 100)</u>
1961	515.0	100.0
1962	650.0	113.0
1963	750.0	130.4
1964	850.0	147.8
1965	875.0	152.2
1966	875.0	152.2
1967	900.0	156.5
1968	1135.0	197.4
1969	1135.0	235.7

Source: Statistical Abstract for Punjab, 1969, p 628.

Under these conditions of high bullock prices, farmers are induced to bring about substitution of draught animals by machinery.

Whereas money wages and bullock prices rose faster than did prices of agricultural commodities in many regions, where the rate of mechanization has also been rapid, the prices of tractor and tractor - fuel seem to have risen by not more than 50 per cent between 1961 and 1968 - compared to a 100 per cent rise in the prices of agricultural commodities over this period. The prices of tractors, e.g. Eicher (27 H.P.) and TAFE (35 H.P.) rose by only 47 per cent between 1961 and 1968 as against a rise of over 124

per cent in foodgrains prices. Even after the mid-sixties i.e. after the commencement of the bulk of indigenous production of tractors, tractor prices lagged very much behind the prices of foodgrains. This can be seen from Table 17.

Thus Hanumantha Rao argues that, farm mechanization currently underway in Indian agriculture represents, in a sense, the response of the prevailing economic system to the population explosion. Whereas in a developed economy the incentives for farm mechanization emanate from rapid industrialization and growth of per capita income resulting in the shortage of labour for the farm sector, in a developing economy like India, the incentive for farm mechanization is provided by the rise in the price of agricultural commodities. The cost of biological sources of energy rises in such a situation, due to the rise in prices of foodgrains as well as the demand for labour outstripping the supply, in pockets of high agricultural growth which are better-endowed regions in terms of physical resources and entrepreneurial ability. One should thus expect a high rate of mechanization to be associated with higher per capita agricultural incomes. In view of this, one should expect the relationship between the rate of mechanization on the one hand, and wage rate, leisure preference and the demand for animal products etc., on the other, to be in the same direction as in a developed economy. The capacity to invest and bear risk in the higher

Table 17: Selling Prices Of Indigenous Agricultural Tractors

Name of the Company	Type of Tractor	Year of commencement of prdn.	Price at the commencement of production (Rs.)	Prices fixed in the middle of 1968 (Rs.)	Prices fixed in early 1971 (Rs.)
	(1)	(2)	(3)	(4)	(5)
<u>Eicher</u>	27 HP	1960	11,900	17,480	19,460
(a) Tractor price Index			100	146.9	163.5
(b) Foodgrains Price Index			100	224.2	204.3
<u>Escorts</u>	27 HP	1966	13,100	13,840	-
(a) Tractor Price Index			100	105.7	-
(b) Foodgrains Price Index			100	148.0	-
<u>Escorts</u>	37 HP	1966	15,400	17,910	19,930
(a) Tractor Price Index			100	116.3	129.4
(b) Foodgrains Price Index			100	148.0	134.9
<u>Hindustan</u>	50 HP	1964	17,500	22,350	24,900
(a) Tractor Price Index			100	127.7	142.3
(b) Foodgrains Price Index			100	198.3	180.7
<u>Hindustan</u>	35 HP	1965	12,500	15,710	17,470
(a) Tractor Price Index			100	125.7	139.8
(b) Foodgrains Price Index			100	158.1	144.1
<u>International</u>	35 HP	1965	16,380	19,570	22,890
(a) Tractor Price Index			100	119.5	130.7
(b) Foodgrains Price Index				158.1	144.1
<u>TAPE</u>	35 HP	1962	14,450	21,140	-
(a) Tractor Price Index			100	146.3	-
(b) Foodgrains Price Index			100	228.4	-

Source: Technological change and Distribution of Gains In Indian Ag. C.H. Hanumantha Rao.

income areas may also be working as important contributory factors for mechanization.

While the above conclusion appears to be valid in general and mechanization in a labour surplus country like India is also taking place under such circumstances, we have seen earlier that there are considerable regional variations in the extent and type of mechanization.

Perhaps, there are different factors in different regions making one or the other sources of energy cheaper and inducing the farmers to use them. It would be interesting and useful to know under what conditions different forms of mechanization are taking place in different regions. In view of this, an attempt has been made to examine the factors responsible for regional variations in the extent and type of mechanization on the basis of the available data and evidence in different studies in this context.

3.2 Regional Variation In The Rate of Mechanization:

Farm Mechanization has not spread uniformly in different states of the country. While some states have been fast adopters of the new technology, others have been lagging behind. This is because while in areas such as the wheat belts of Punjab and Haryana, Western U.P., the deltaic rice belts of Tamil Nadu and Andhra Pradesh factors are conducive to mechanization, in other states there are certain other factors which inhibit the growth of farm mechanization.

In the subsequent sections therefore, the factors

affecting tractorization and those affecting demand for irrigation pumpsets in some of the different states in India are examined.

3.2.1 Factors Affecting Tractorization In The Different States Of India:

Punjab & Haryana: Punjab, some analysts have argued, is ahead of the rest of India by a few years. This is mainly because there are crucial differences between the environmental and institutional conditions in the agriculture of Punjab and the rest of the country.

In 1974-75 out of the Rural Households, Agricultural Labour Households constituted only 13.72 per cent in Punjab & Haryana.¹⁵ Thus labour shortage was felt for farm operations such as ploughing. Also, the area under irrigation in these states was very high relative to other states in India. The net irrigated area formed 61.4 per cent of the net cultivated area in Punjab & Haryana.¹⁶ The greatest coverage of high yielding varieties of wheat is in these two states, accounting for over three-quarters of the total irrigated area under wheat in the state. The characteristic feature of the HYV's is their short maturity span. A shorter maturity of crop implies that

15. Rural Labour Enquiry, 1974-75, Final Report On Employment And Unemployment Of Rural Labour Households (Part I); pg 20-21, Labour Bureau, Ministry of Labour, Government of India, Chandigarh.

16. All India Report On Agricultural Census 1970-71, p43, Government of India, Ministry of Agriculture And Irrigation, Department of Agriculture, New Delhi.

the required energy should be applied in intense doses as the time available between two crop operations is considerably reduced. Further, introduction of short maturity span crops has vastly increased the scope for intensifying the land use through multiple cropping. Under a multiple cropped system, the time available is again shortened between harvesting of one crop and sowing of the next one. Under the changed conditions of crop cultivation, with short maturity span of crops and multiple cropping, the pattern and intensity of demand for energy has changed radically. As the conventional sources of human and bullock energy failed to provide the energy in required doses and in required time, farmers in Punjab & Haryana who accepted the HYV seed technology, have resorted to mechanical motive power to save time and thereby get maximum output.

Mechanization of agriculture in general and tractorization in particular, is an integral part of the package of practices associated with HYV seed technology in these high growth pockets. It is, therefore, not surprising that tractorization has made its appearance and made rapid strides in the wheat belt of Punjab & Haryana.

In so far as the farm size plays any role in tractorization, the size of the average farm in the Punjab is much larger than that in most states. The average size of a holding in Punjab is 2.89 hectares and in Haryana it is 3.78 hectares.¹⁷ This size is above the Indian average

17. Ibid., p41.

size of holding which is 2.3 hectares.¹⁸

The Punjab experience is also unique for an additional reason. The growth of small scale industry has been rapid and extensive over the districts. This has acted as a pull to labour, and increased job opportunities in the small industry sector has raised the opportunity cost of labour. Part of the wage rise in the Punjab could be due to the expansion of the non-farm sector.

Besides rise in wages, the price of bullocks in Punjab experienced a sharp rise as noted earlier. This induced the farmers in Punjab to substitute draft animals by machines.

Given these considerations, farm mechanization is inevitable in Punjab and it seems to promise modernization of its agriculture and perhaps a rapid structural shift from agriculture to industry.

Uttar Pradesh: Next to Punjab is Uttar Pradesh, as far as the use of tractors is concerned. The main point to be noted is that a large part of the tractor stock in U.P. is located in the agriculturally advanced western districts of the state. Eastern U.P. is still agriculturally backward and only western U.P. represents one of the pockets of high growth. Data on size of holding, area under irrigation etc. are however not available separately for East and West U.P.

18. Ibid., p41.

U.P. seems to be experiencing a shortage of labour which has resulted in use of mechanical power for certain farm operations. Agricultural Labour Households constituted 15.81 per cent of Rural Households.¹⁹ U.P. has the largest number of operational holdings (22.2 per cent of the total holdings in the country).²⁰ A study on "Farm Mechanization In Western U.P." by Roshan Singh and B.B. Singh indicated that about three-fourths of the mechanized farms are of a size upto 20 hectares.²¹

In absolute terms, the largest area under HYV's of wheat is in U.P. (about 2 million hectares).²² Net Irrigated area constitutes 41.5 per cent of the net cultivated area.²³ The use of HYV's enabled more intensive use of land due to their short duration. More farm power which was thus required was brought about introduction of mechanical power. The study by Roshan Singh and B.B. Singh also stated that mechanization has been mainly undertaken to increase farm productivity.

19. Rural Labour Enquiry, op.cit., p 20-21.

20. Agricultural Census, op.cit., p 42.

21. Singh, Roshan, and B.B. Singh, "Farm Mechanization In Western U.P.", p141, In Problems Of Farm Mechanization, ed Indian Society of Agricultural Economics, February 1972.

22. Agricultural Census, op.cit., p66.

23. Ibid., p43.

Andhra Pradesh & Kerala: Andhra Pradesh, among the states in South India, seems to have gone ahead with respect to the use of tractors. A study by Sastry and Mukherjee²⁴ on "Tractor Farming And Employment of Hired Labour" - gives data on percentage of participants resorting to tractor ploughing in all areas and in package areas. In Andhra Pradesh and Kerala the percentage of participants resorting to tractor ploughing was generally higher in the package areas. The data by size of holding revealed that, in Andhra Pradesh for paddy cultivation, intensive cultivation prompted the use of tractor. In the big farms however, tractors were used to economize on farm labour. The explanation seems to be that big farmers have to manage large areas requiring timely operations to be done quickly. In Kerala the ruling high wage rates prompted the use of tractors. Collective bargaining power and trade unions in Kerala keep the wage rates high. Hence farmers used tractors to economize on farm labour.

Maharashtra: A survey conducted by the NCAER²⁵ reported that the adoption of mechanical devices is not always

24. Sastry G.A. and P.K. Mukherjee, "Tractor Farming And Employment Of Hired Labour - A Case Study In HYVP Areas", p122, In Problems Of Farm Mechanization, ed Indian Society Of Agricultural Economics, February 1972.

25. National Council Of Applied Economic Research, Implications Of Tractorisation For Farm Employment, Productivity And Income, p47, Volume I, New Delhi, Rakesh Press, 1980.

influenced by scarcity of labour. For instance, farmers in certain districts of Maharashtra inspite of having meagre irrigation facilities are using tractors because of the following reasons:

- (1) Excessive growth of certain types of weeds which cannot be controlled by bullock ploughing. A deep ploughing with tractors, it is claimed can remove the weeds completely resulting in higher yield on a unit of land area.
- (2) Deep ploughing with tractors improves the drainage system in hard clay soils, enhancing the moisture - retention capacity of the soil, leading to higher yields under dry farming conditions.
- (3) Timely ploughing and preparatory tillage operations for wheat sowing a crop of sugarcane is difficult with bullocks. Consequently, farms are left fallow in the following rabi season. This crop sequence can be achieved by tractors. Also, farmers prefer tractors in Maharashtra as the soil is hard and can be better ploughed with tractors.

Rajasthan: Rajasthan is a state where the average size of a holding is 5.4 hectares.²⁶ Moreover, Rajasthan suffers from acute shortage of labour. The Agricultural Labour Households constitute only 3.96 per cent of the Rural Households.²⁷ But the main factor inhibiting rapid

26. Agricultural Census, op.cit., p41.

27. Rural Labour Enquiry, op.cit., p20-21.

mechanization in Rajasthan is inadequate irrigation facilities. The percentage of net irrigated area to net cultivated area is 13.9 per cent.²⁸ Thus due to inavailability of irrigation, multiple cropping is not easy to undertake. The investible surplus in the hands of the farmers is not much to provide incentive for mechanization. As more and more area comes under irrigation, the scope for mechanization will improve rapidly. The state offers considerable potential for expanding wheat production through greater coverage of HYVP; only 37 per cent of the total irrigated wheat area had been brought under this programme in 1970-71.²⁹ In the States of Assam, West Bengal, Orissa the spread of tractorization is still very slow. The average size of a holding is small in these states. For example, in Assam the average ^{size} of a holding is 1.47 hectares and in West Bengal it is 1.20 hectares.³⁰ This is well below the average size of a holding in India which is 2.30 hectares.³¹ In Assam only 0.3 per cent of the holdings are large (above 10 hectares and 5 per cent of the holdings are medium-sized (4-10 hectares)).³²

Besides these states do not have labour shortage. In

28. Agricultural Census, op.cit., p43.

29. Ibid, p67.

30. Ibid., p41.

31. Ibid., p41.

32. Ibid., p130.

West Bengal and Orissa for instance agricultural labour households constituted 30 per cent of rural households.³³

These states also do not have adequate irrigation facilities. In Assam 7.9 per cent of the net cultivated area is irrigated and in Orissa it is 12.8³⁴ per cent. Under these circumstances multiple cropping is not easy. The use of HYV's is not popular in these states. These seeds require water at frequent intervals and are sensitive to water shortage. Due to inadequate irrigation double cropping and multiple cropping which require timely operations and more farm power, is not undertaken. Thus an important incentive to tractorization does not exist.

In light of the above, it can be concluded that in a country like India, factors responsible for the growth of mechanization in agriculture vary from region to region due to initial differences in the resource endowment and varying levels of infra-structure development. Also, the new technology is largely confined to irrigated and assured rainfall areas. Tractorization made rapid strides in Punjab & Haryana, West U.P. and other areas which accepted the new seeds. This suggests a close correlation between HYV seed technology and tractorization.

3.2.2 Factor Affecting Demand For Irrigation Pumpsets:

Since the Third Five Year Plan emphasis has been laid

33. Rural Labour Enquiry, op.cit., p

34. Agricultural Census, op.cit., p43.

not only on the development of major and medium irrigation projects, but also on the expansion of minor, particularly lift irrigation sources. Consequently, lift irrigation has come to acquire a significant place in the total area under irrigation in the country as can be seen from Table 18.

The committee³⁵ to estimate the demand for pumpsets stated that the ultimate irrigation potential feasible from all sources expressed in terms of area that can be irrigated, is 112 million hectares of which 40 million hectares or about 36 per cent would be with groundwater, which forms the bulk of all sources of lift irrigation in the country. At the beginning of the First Plan, groundwater accounted for less than 30 per cent (6.5 million hectares) of the total irrigated area. Since the Third Plan onwards, the importance of groundwater increased. By the end of 1977-78, area irrigated by groundwater formed about 38 per cent (19.8 million hectares) of the total irrigated area.

The sources of lift irrigation are dug wells, deep and shallow tube wells, small rivers and streams. Almost all new dugwells are being fitted with such pumps and the tubewells are of course operated by electric or diesel

35. Agricultural Refinance And Development Corporation (ARDC), Report Of The Committee To Estimate The Demand For Pumpsets During 1978-83 and Study The Policy And Procedure For Financing It, p6, 7, Examiner Press, Bombay, 1979.

Table 18: Development Of Irrigation During The Five Year Plan Period.

Sources of Irrigation	Area Irrigated in 1950-51	Total Potential Created by the end of -			Area In Million Hectares.		
		1968-69	1973-74	1977-78	Additional Potential proposed to be created during 1978-83	Targeted to- tal poten- tial by the end of 1982-83	Ultimate Irrigation Potential Feasible
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Surface water	16.1	24.6	27.7	32.5	10.0	42.5	72.0
a) Major & Medium	9.7 (43)	18.1 (49)	20.7 (47)	25.0 (48)	8.0	33.0 (47)	57.0 (51)
b) Minor	6.4 (28)	6.5 (17)	7.0 (16)	7.5 (14)	2.0	9.5 (14)	15.0 (13)
2. Groundwater	6.5 (29)	12.5 (34)	16.5 (37)	19.8 (38)	7.0	26.8 (39)	40.0 (36)
3. Total	22.6 (100)	37.1 (100)	44.2 (100)	52.3 (100)	17.0	69.3 (100)	112.0 (100)

Note: Figures In Brackets are percentages to the total.

Source: Report of The Committee To Estimate The Demand For Pumpsets During 1978-83, And Study The Policy And Procedure Of Financing It. (Agricultural Refinance And Development Corporation, Bombay, 1979, p 6).

engines. The committee expressed that the demand for installation of diesel engines or electrically operated pumps for purposes of irrigation in 1978-83, will depend, among other things, on the number of dugwells that remain to be fitted with pumps and the number of new dugwells and tubewells that may be sunk during the period, which in turn depend upon the availability of groundwater on the one hand, and cheap and easy availability of diesel oil or dependable supply of electricity on the other.

In the past, factors such as inadequate and/or uncertain availability of groundwater in some areas, inadequate development of infrastructure facilities like roads, diesel oil shops and electricity in other areas, and finally obstacles arising out of fragmented holdings, restricted rights in land, inadequate knowledge on the part of the farmers, besides financial difficulties, have been responsible for the lag in the development of sources of lift irrigation. However, during the last decade, due to the increased potential created for groundwater, mechanization in the form of irrigation pumpsets is increasing as was observed in the previous chapter.

Factors Affecting Mechanization Of Lift Irrigation In The Different States Of India:

There are wide variations in the number of pumpsets among the various states in India. In this respect, while Tamil Nadu is in the forefront, states such as West Bengal and Orissa are far behind.

Differences in the net area irrigated by wells and differences in the spread of rural electrification, largely explain why there are variations in the number of pumpsets in the various states of the country. Hence, before proceeding with a state-wise analysis, it is necessary to take note of the net area under well irrigation and the number of villages electrified (which affects the demand for electric pumpsets) in the various states. These are presented in Tables 19 & 20 respectively.

Tamil Nadu: A study by Muthiah³⁶ on 'Farm Mechanization In Tamil Nadu' revealed that the state occupies a predominant place in the country with respect to irrigation pumpsets. The top priority given to rural electrification (which is 99 per cent) by the planners of Tamil Nadu, has given a great fillip to installation of electric pumpsets by farmers over the years. Initially, the growth of pumpset irrigation was significant in areas like Coimbatore where cash crops like cotton and groundnut are important. But gradually the growth has been widespread throughout the state. Even in canal irrigated areas like Thanjavur, electric pumpsets are being installed in large numbers to provide for early and supplemental irrigation. With the introduction of high-yielding varieties programme over a wide area, the growth of pumpsets in recent years has been

36. Muthiah, C., "Farm Mechanization In Tamil Nadu" p156, In Problems Of Farm Mechanization ed Indian Society Of Agricultural Economics, February 1972.

**Table 19: Net Area Irrigated By Wells (Tube-wells
And Other Wells) - Statewise, 1976-77**

Area in Thousand Hectares

State	Area Under Well Irri- gation	Total Area Irrigated	Per cent of Well Irrigated Area to Total Irrigated area
1. Andhra Pradesh	624	3,434	18.17
2. Assam	-	572	-
3. Bihar	1,183	2,879	41.09
4. Gujarat	996	1,233	80.77
5. Karnataka	327	1,215	26.91
6. Kerala	47	221	21.26
7. Madhya Pradesh	775	1,982	39.10
8. Maharashtra	1,064	1,833	58.04
9. Orissa	104	1,049	9.9
10. Punjab & Haryana	2,536	4,992	50.80
11. Rajasthan	1,486	2,608	56.97
12. Tamil Nadu	825	2,330	35.40
13. Uttar Pradesh	4,793	8,260	58.02
14. West Bengal	17	1,489	1.14
15. Union Territories	52	130	40.00
All India	14,840	34,799	42.64

Source: Indian Agriculture In Brief, Eighteenth Edition.

Table 20: Number Of Villages Electrified

State	Total No. of villages	Number elec- trified in 1979	Per cent of villages electrified to total villages
1. Andhra Pradesh	27,221	15,453	56.77
2. Assam	21,995	3,001	13.64
3. Bihar	67,566	18,703	27.68
4. Gujarat	18,275	9,464	51.79
5. Karnataka	26,826	15,720	58.60
6. Kerala	1,268	1,248	98.42
7. Madhya Pradesh	70,883	19,350	27.30
8. Maharashtra	35,778	23,384	65.36
9. Orissa	46,992	15,568	33.12
10. Punjab & Haryana	18,914	18,857	99.70
11. Rajasthan	33,305	12,311	36.96
12. Tamil Nadu	15,735	15,525	98.67
13. Uttar Pradesh	112,561	36,298	32.24
14. West Bengal	38,074	12,163	31.94
15. Union Territories	4,685	1,336	28.51
India	5,75,936	2,32,770	40.41

Source: Indian Agriculture In Brief, Eighteenth Edition.

significant, even in predominantly grains crop region.

The study stated that the factors responsible for such marked progress briefly are:

- (1) Government policy for rapid and large scale rural electrification programme.
- (2) Liberal co-operative and Government credit facilities.
- (3) Low electricity rates (lowest in the country) for pumpsets.
- (4) Low capital investment required for a borewell in relation to digging an open well.
- (5) Enhanced profitability on account of increased production achieved through intensity of cultivation and diversity of cropping.

All the above factors paved the way for development of lift irrigation in Tamil Nadu where the percentage of well irrigated area to total irrigated area is 35 per cent. In 1972, Tamil Nadu possessed 28 per cent of the total pumpsets in the country. Also, it was reported by the Rural Electrification Corporation that in 1978, Tamil Nadu had 809,606 electrically operated irrigation pumpsets (The highest in the country).

The committee's report to estimate the demand for pumpsets (1978-83) indicated that the bulk of the groundwater potential is mainly in the four districts of Thanjavur, Pudukottai, Ramanathapuram and Kanyakumari. The other districts are either being over-exploited or have reached their limits.³⁷ As more groundwater gets exploited, the

37. ARDC, op.cit., p13.

demand for pumpsets will increase.

Maharashtra: In the state of Maharashtra too, the number of irrigation pumpsets is very high. The area irrigated by wells is 58 per cent and groundwater is available in fairly large quantities. Electrical energy however, appears to be a bottleneck. In summer the pumps do not get power for about half the time. 65 per cent of the villages in Maharashtra are electrified; but, as rural electrification spreads further and more electricity becomes available, a marked increase in the number of pumpsets will be observed.

Gujarat: In Gujarat, well irrigation accounts for 80 per cent of the total area under irrigation. This to a large extent explains why the number of irrigation pumpsets is so high in Gujarat. The ARDC³⁸ study noted that groundwater availability is not a constraint in this state. The number of villages electrified in this state are 52 per cent. Rural electrification was much lower in 1972 when 89 per cent of the total pumpsets were operated by diesel oil and 11 per cent by electricity. With the increase in rural electrification more and more pumps are being operated by electric power. Thus in this state it is necessary that rural electrification must spread even more rapidly so that the number of electric pumpsets may increase. High price of diesel oil also provides incentive to the farmers to switch over to electric pumpsets.

38. Ibid., p14.

Punjab & Haryana: In the states of Punjab & Haryana rural electrification is nearly 100 per cent. The area under well irrigation is 51 per cent. Also, there is availability of groundwater and as irrigated farming is profitable, further expansion of tubewell irrigation is anticipated. All these factors have increased the number of pumpsets over the years. Moreover, there is a growing use of underground water for irrigation in the areas already under the command of canals in the state. Demand for pumpsets for such supplementary irrigation is likely to increase, particularly in areas which are liable or likely to be exposed to water logging.

In Punjab & Haryana, like in most other states, expansion of pumpsets consisted mainly of electric ones. This was because of extension of rural electrification, on the one hand, and the rising price of diesel oil on the other. The ARDC³⁹ study reported that the current state policy for charging for electric power at a flat rate based on the H.P. of the motor, was another factor which encouraged demand for electric pumpsets. Farmers, however sometimes find it convenient to use the same engine for pumping at different wells or tubewells on their farm; diesel engine is more convenient than electric for such purposes and this factor may encourage demand for diesel pumpsets.

39. Ibid., p11.

Andhra Pradesh: The number of pumpsets in Andhra Pradesh is fairly high, relative to the rest of the country. The area under well irrigation is 18 per cent. Over the years, the number of electrically operated pumpsets is increasing as rural electrification is spreading. The number of villages electrified in 1979 were 57 per cent. Besides, in Andhra Pradesh ground water is also available. The real problem in this state is the ability of the rural economy and the supporting institutions to translate the possibilities into actualities. As the state has underground water as well as electric power and if these two resources are fully exploited, the progress of lift irrigation will be more rapid.

Kerala: In Kerala 21.2 per cent of the area irrigated is under well irrigation. Rural electrification is 98 per cent in Kerala. As electric power is available and also there is a considerable quantity of groundwater, the number of electric pumpsets are registering an increase over the years.

Rajasthan: Rajasthan is not a state with extensive groundwater resources, but according to data available with the ARDC, study hardly 15 per cent of this is yet tapped.⁴⁰ It is also a power-deficit state. Only 37 per cent of the villages in Rajasthan are electrified. Due to these factors, the number of pumpsets is fairly low in Rajasthan.

40. Ibid., p15.

However since 57 per cent of the area is under well irrigation in Rajasthan it appears that traditional devices such as persian wheel or moht are being used.

In states such as Assam, Bihar, West Bengal, Orissa, Madhya Pradesh, there is plenty of groundwater potential, but very little exploitation of it so far. In these states, the ARDC⁴¹ study noted, the problem is not one of availability of water, but awareness about the urge for the possibilities and benefits of lift irrigation, of the necessary institutional structure and leadership at the ground level like co-operative credit societies and Land Development banks, of the efficiency of state and district administration in not only extension activity but also in helping in the promotion of lift irrigation among farmers, as well as in the provision of the necessary infra-structure like rural electrification, development of roads and communications, and of easily accessible points of supply of materials and equipment needed for the purpose. The relatively poor economic position of many of the State Governments puts further limits on their initiative in all these fields. Besides, there is the problem of lack of proper record of rights in land, of tenancy, of fragmentation of landholdings and sometimes, of very small land holdings particularly in the paddy growing regions of these states. Because of these factors, progress of lift

41. Ibid., p15.

irrigation and use of underground water for the purpose has been very slow in most of these states. The speed of lift irrigation in these states will only increase once the barrier of lack of awareness and motivation is broken.

On the basis of the available evidence, it can be concluded that there are wide variations in the level of mechanization in different states of the country. The use of lift irrigation machinery which is an index of mechanization of irrigation depends on factors such as availability of groundwater, rural electrification, availability of diesel oil etc. In areas which have the facility of canal irrigation, the opportunity for the use of such machinery may be limited.

3.3 Farm Credit And Mechanization:

Apart from the factors, discussed in the preceding sections, which play an important role in influencing farm mechanization, the availability of credit is also assuming special importance as a factor promoting mechanization.

Loans given by the banks for the purchase of agricultural implements in 1977-78 are presented below:

State Co-operative Banks

Medium-term loans (Purchase of Machinery, Pumpsets for irrigation)	Rs. 6.83 crores
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Central Co-operative Banks

Short-term (Purchase of agricultural implements)	Rs. 5.5 crores
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Medium-term (sinking of or repair of wells)	Rs. 7.9 crores
(Purchase of Machinery)	Rs. 6.7 crores

Primary Agricultural Credit Societies

Short-term (Purchase of agricultural implements)	Rs. 6.6 crores
Medium-term (sinking of/repair of wells)	Rs. 9.7 crores
(Purchase of agricultural machinery i.e. oil engines etc.)	Rs. 13.2 crores

Central Land Development Banks

Sinking of or repairs of wells	Rs. 64.23 crores
Purchase of machinery (includes rural electrification)	Rs. 119.94 crores

Source: Review of the Co-operative Movement In India 1976-8; Reserve Bank of India.

From the above figures it can be concluded that loans given for the purchase of agricultural implements by the various co-operative banks is fairly large. There may however be some double counting in the amount of loans given as the amount is sometimes passed from one co-operative bank to another. Loans were given for the purchase irrigation pumpsets, spread of electrification, sinking tube-wells and for purchase of tractors. This has greatly helped the farmers to purchase agricultural implements and thus speed up the progress of mechanization.

Loans given by commercial banks to state electricity boards for energisations of wells etc. in 1979 amounted to Rs. 11055.7 lakhs.⁴²

ARDC provides refinance facilities for purchase of

42. Reserve Bank of India, Statistical Tables Relating To Banks In India, pg34, 1979.

tractors and other allied machinery requiring medium and long-term investments.⁴³ As regards tractors, ARDC appraisal norms provide that incremental income (including custom hiring) from the investment should be adequate to enable the borrowers to repay the loan within a period not exceeding 7 years, the economic life of the asset.

ARDC implemented six IDA assisted credit projects, viz. Punjab, Haryana, Gujarat, Andhra Pradesh, Karnataka, and Tamil Nadu involving purchase of imported/indigenous tractors; under these projects as many as 1907 tractors were financed.

The ARDC has also placed considerable emphasis on the establishment of Agro-Service Centres during the period 1978-83, so that small and marginal farmers can resort to mechanized farming and take on to cultivation of HYV's. The Agro-Service Centres provide custom services, by hiring out tractors and make provisions for repairs and maintenance of farm machinery, supply of spare parts and supply of other agricultural inputs such as HYV's, fertilizers.

It therefore appears that participation by the various financial institutions has facilitated the progress of farm mechanization. Once adequate funds are channelized for agricultural mechanization, the progress will be more rapid.

43. Agricultural Refinance And Development Corporation, Third Agricultural Refinance And Development Corporation Credit Project, Part II, Sector Notes, Annex 4, June 1978.

CHAPTER IVIMPACT OF MECHANIZATION ON EMPLOYMENT

With the emergence of the concept of "welfare", greater emphasis is placed in State policies on the creation of job opportunities for the unemployed which also helps in reducing poverty. Farm mechanization, in a poor country like India, with modest capital resources and with a large population dependent on agriculture, it is feared, will lead to a shift in technology contrary to the resource endowment of the country and therefore aggravate the problem of unemployment. This view is however not borne out by certain studies which indicate that employment may not decrease since the labour requirement of the new technology is larger than that of the old, and since shift to multiple cropping on a large scale, which the new technology makes possible, would substantially raise the demand for farm labour.

In view of the emphasis on employment augmenting policies, a number of studies focussed attention on evaluating the impact of mechanization on employment. In the subsequent sections therefore, an attempt has been made to review the literature available on this aspect of mechanization.

4.1 Mechanization With Reference To Each Operation:

The growing of a crop, like any other productive activity, is composed of a series of interlinked operations

each assisting in the final task of making a commodity available for consumption. To the extent each operation in a productive activity is distinguishable it is possible to employ different technologies for different operations. One can, for example, plough with a tractor and harvest with a sickle without much detriment to the quantity and quality of the product.

The main agricultural operations are:

- (i) reclamation of cultivable waste lands and cultivated lands which are infested with pernicious weeds,
- (ii) preliminary tillage operations including deep ploughing of land,
- (iii) sowing and transplanting,
- (iv) weeding and other inter-cultural operations,
- (v) irrigation,
- (vi) harvesting or picking in the case of fruits and crops like cotton, and also
- (vii) threshing of the crop.

Shivamaggi in his study on "An integrated Approach to Agricultural Mechanization In India"⁴⁴ emphasized that it is necessary to analyse the case for farm mechanization with reference to each item of agricultural operations.

Land Reclamation and Making Land Fit For Cultivation:

There are some waste lands in the country belonging

44. Shivamaggi, H.B., "An Integrated Approach To Agricultural Mechanization In India", in Problems Of Farm Mechanization, p55, ed. Indian Society of Agricultural Economics, Seminar Series IX, February, 1972.

either to the Government or to individual owners which can be brought under cultivation with the reclamation programme involving removal of weeds and shrubs, levelling and deep ploughing. If this work is to be done with the help of human labour, it will involve employment of a large number of workers at a time, which in practice has been found difficult owing to non-availability of large number of workers for employment on a continuous basis on such schemes, problems of managing these labourers even if they are available and heavy cost of reclamation scheme if the scheme is to be carried out with the help of human labour only. Even where labour is available, the preference has been for using heavy machinery for reclamation work because the quality of work done through machines is decidedly better than that done with the help of labour. In fact, labour cannot simply handle some of the work involved in reclamation.

Taking these facts into account, it appears that the reclamation work through machines cannot be construed as involving displacement of or adverse effect on labour. On the contrary, as a result of reclamation of waste tracts, Shivamaggi argues, there would be more extensive and intensive agriculture which in effect would create more opportunities for employment. It is for this reason that there should be no hesitation in undertaking mechanization of land reclamation programme including the deep ploughing of already cultivated lands which are infested

with pernicious weeds. It must however be remembered that this stage of mechanization namely land reclamation cannot go on endlessly but will come to an end once the entire waste land is reclaimed.

Ploughing, Harrowing Other Preliminary Tillage Operations:

Traditionally, wooden plough drawn by bullocks and more recently iron plough is the most important implement used for ploughing operations. For the preliminary tillage operations, it is mostly the bullock labour which is more important and as such any attempt to introduce power-drawn machinery for carrying out these operations will chiefly result in bullock displacement and not labour displacement. As such, there is no prima facie case against mechanization of these operations based on the argument that it will create large scale unemployment. In fact, the use of a tractor for these operations does qualitatively better work in time. Hence, it is desirable to use tractors for the purpose of ploughing and harrowing while machinery may not be used much for other preliminary tillage operations such as seed-bed preparation etc. since it would displace labour as these operations are more labour intensive.

Mechanization Of Lift Irrigation:

Before the advent of oil engines and pumpsets, the main appliance for lifting water from wells and ponds was the Persian Wheel or Mohat, operated by bullock or human labour. When water lifting power appliances appeared on the scene, they revolutionaized irrigation. The rapid

development of minor irrigation in recent years can be attributed mainly to this. As oil engines and electric pumpsets are available, it has become possible to augment irrigation on such a scale that could not have been achieved by bullock or human power. Mechanization of irrigation including introduction of sprinkler system of irrigation in scanty rainfall areas to conserve available supplies of water is absolutely necessary for India.

Displacement of bullock labour is the main impact of using oil engines for irrigation and with it human labour is also marginally displaced. But increase in demand for both bullock and human labour as a result of change in crop pattern and multiple cropping is of such magnitude that actually the farmer with mechanized lift irrigation may find it difficult to cope up with increased power requirement of his farm.

There is therefore really no problem as such with regard to mechanized irrigation.

Sowing, Transplantation, Weeding, Harvesting & Threshing:

These are labour intensive farm operations in the true sense of the term and indiscriminate adoption of labour saving machines for these operations will displace labour considerably. Power-tillers, light tractors, harvesters are the chief machinery for these operations and their use may accentuate the problem of rural unemployment.

While the above is the context calling for a cautious

approach in respect of these items, the demand for such machinery has been going up in areas of labour scarcity. The landowners in paddy and wheat areas are keen to reduce their dependence on labour particularly for harvesting.

Also, complete ban on mechanization of certain operations is likely to come in the way of multiple cropping which requires sowing, harvesting and drying of crops to be completed within the short time gap between one crop and the next. In these cases perhaps, there is justification from the individual farmers point of view, placed as he is, for the use of mechanical driers, power tillers, harvesters and threshers. For e.g. in Punjab, where acute labour shortage is felt in peak seasons and where wage rates are high, use of appliances such as harvesters and threshers may be necessary.

4.2 Impact Of Mechanization On Employment As Revealed By Certain Studies:

Most studies undertaken on the "Impact of Mechanization On Employment" revealed that the use of mechanical appliances such as tractors and pumpsets would reduce the man-days required for individual agricultural operations. However, many economists argue that when such mechanization is associated with HYV technology, the labour-augmenting effects of the concomitant higher cropping intensity (made possible by HYV technology and possibly, by mechanization) and the higher yields per cropped hectare (due to HYV technology, which requires more labour per unit of cropped area) more than compensate for any labour displacement per

cropped hectare. Simply stated, the argument runs that the extra labour required to cultivate a crop when HYV technology is used, plus the extra labour employed in cultivating the second crop, more than offsets the reduced labour input for the first crop that results from mechanization of some operations.⁴⁵

Also, mechanization in agriculture gives rise to non-farm employment in the production, sale and maintenance of the mechanical appliances used in agriculture. Moreover, once admitted that mechanization increases production and disposable income of the farm operators it should have a multiplier effect. Demand released through this effect for consumer goods, services and investment material would generate further demand for labour both within and outside the farm sector. The study on this aspect has not been explored in great depth and most studies merely state that mechanization generates indirect employment through the multiplier effect.

Martin Billings and Arjan Singh in their study on "Labour And The Green Revolution - The experience In Punjab"⁴⁶ examined some implications of the different degrees of mechanization in the wheat growing areas of Punjab. It is based on a study of a 10-acre well water

45. Bartch, William H., Employment And Technology Choice In Asian Agriculture, New York, Praeger Publishers, 1977.

46. Billings, H. Martin, and Arjan Singh, "Labour And The Green Revolution - The Experience in Punjab", Economic And Political Weekly, December 27, 1969.

irrigated farm with a typical cropping pattern and using traditional technology. The trade-off in labour demand for various mechanical devices has been introduced at the following rates on a per acre basis: (1) pumpsets, rated at $1/4$ th of the man-hours required with a persian wheel (2) wheat thresher, at $1/4$ th of the man hours required with the indigenous method (3) tractors, at $1/5$ th of the man hours required with bullock-drawn improved implements (4) reaper at $1/5$ th of the man-hours needed with the traditional method (5) corn sheller, at $1/7$ th of the labour formerly required.

The farm is examined through seven technical changes beginning from the first stage where the farm uses traditional technology and is irrigated with a persian wheel. The demand for energy is expressed in Table 21 on a monthly basis to give a clearer impression of the importance of peak seasons and timeliness of operations as these are affected by mechanization. The cropping intensity at Stage I is 150 per cent.

In stage II the farm still using persian wheel irrigation adopts High Yielding Varieties with fertilizers and pesticides. Of itself this package of inputs does not affect the cropping intensity, but, it does influence the demand for energy, which increases 18 per cent above stage I. The increase in demand for labour arises because of the substitution of indigenous seeds by high Yielding Varieties. The HYV demand faster seed-bed preparation to

gain full benefit from their shorter duration and hence their initial effect is labour-intensive. Also the high Yielding Varieties have a higher reproduction rate than the traditional varieties and therefore their use will require more labour for operations such as harvesting and threshing. Thus we find that in Stage II when HYV's along with fertilizers and pesticides are adopted the demand for labour increases from 510.0 man days to 600.7 man days.

In Stage III a mechanical pumpset is used which cuts down the time required for irrigation by $3/4$ th. At the same time however, use of a pumpset for irrigation purposes raises the cropping intensity which increases the demand for labour. The cropping intensity has increased from 150 per cent to 180 per cent. An extra crop would mean extra sowing, extra harvesting and threshing which would demand more labour. Thus though the time required for irrigation has been reduced by $3/4$ th this loss in labour requirement, to a certain extent is offset by an increase in cropping intensity. The annual demand for labour which was 600 man-days in Stage II has fallen to 592 man-days which is a decline of only 1.5 per cent.

In Stage IV a corn sheller is introduced into the farm operations. It reduces the demand for labour in maize production by 15.5 per cent as compared to Stage III. In Stage IV a mechanical wheat thresher is also introduced which reduces the demand for labour by 21 per cent in wheat production as compared to Stage III. Threshing is one of

the severe bottlenecks confronting wheat farmers - especially so since the introduction of HYV's. The increased demand for labour during the wheat harvesting month April-May results in high wage rates in Punjab. This induces the farmers to use wheat threshers. Thus there is a fall in annual demand for labour in Stage IV. It was 591.8 man-days in Stage III but has fallen to 525.0 man-days in Stage IV. Also, there is no change in cropping intensity which is still 180 per cent.

The tractor is introduced in Stage V. It has already appeared on Indian farms and is rapidly gaining ground. The machine is largely used in ploughing and seed-bed preparation although it is also used in inter-culture for row crops and running power-operated machines like cane crushers, chaff cutters etc., in the absence of electricity. The effect of the tractor will be to reduce the demand for labour for wheat production by about 30 per cent, for maize production by 18 per cent, for cotton production by 26 per cent and by 23 per cent for cane production as compared to Stage IV. The fall in demand for labour from Stage I to Stage V is 20 per cent. The annual demand for labour in Stage IV was 525.0 man-days but with the introduction of the tractor it has fallen to 422.4 man-days in Stage V.

One additional effect of the introduction of tractors must be remarked upon viz. displacement of bullocks as draft animals. This substitution will permit a part of the area presently under fodder crops to be devoted to crop

production.

Reaping presently represents the greatest single labour cost to the farms in wheat production. It is therefore one activity in which there is considerable incentive for using labour-saving devices. It is estimated that at the sixth stage when a mechanical reaper is introduced, it will cause the demand for labour for harvesting wheat to decline by 4/5th. It may be underscored that this activity represents the highest income period for labourers over the crop year. In Stage V the annual demand for labour was 422.4 man-days. The introduction of a reaper has reduced the demand for labour to 374.4 man-days in Stage VI.

Compared to the original farm using traditional technology, total mechanization increases cropping intensity by at least 30 per cent, while it reduces demand for labour from 510 man-days to about 374 man-days, i.e. by 27 per cent from Stage I to Stage VI.

The new technology can permit remarkably greater cropping intensity than hitherto possible which will use extra labour. An extra crop will mean an extra planting and harvesting, which represents an extra high income to workers. An e.g. is offered on a 10 acre farm producing at 220 per cent cropping intensity by growing an extra acre on maize crop in addition to potatoes (2 crops) grown in succession on the same land and also a short-duration pulse crop, moong, grown after wheat on 4 acres. These activities

permit an increase in man days required, by 32 per cent above the level postulated in Stage VI. (In Stage VI total man-days required were 374.4 and in Stage VII it increased to 493.6). From Stage I to Stage VII the reduction in man-days is only 3 per cent.

Billings and Singh⁴⁷ projected that by 1983-84 farm machinery is expected to become a common feature in Punjab farm practices, when it seems possible that nearly 100 per cent of wheat will be mechanically threshed, 100 per cent corn will be shelled by corn shellers, 20 per cent of the gross cropped area tilled by tractors; 50 per cent of the wheat crop mechanically reaped and 60 per cent of the area will be irrigated by pumpsets and tube wells. These changes from the conventional technology are feasible if no radical changes occur in public policy regarding mechanization and if relationships between farm costs and prices remain sufficiently favourable. With these changes in the methods of crop production, total human energy demand in 1983/84 in Punjab will be reduced from the conventional level by 17.4 per cent.

In the State of Maharashtra, Billings and Singh studied the effect of four technological changes: HYV pumpsets, power threshers, and tractors. The HYV increased

47. Billings, H. Martin, and Arjan Singh, "The Effect of Technology On Farm Employment In India", In Agricultural Development In Developing Countries - Comparative Experience, ed Indian Society of Agricultural Economics, Papers and Proceedings of An International Seminar held at New Delhi, Oct. 25-28, 1971.

Table 21: Monthly Demand For Human Labour On A 10 Acre Well Irrigated Farm In Punjab At Different Levels Of Mecnanization

Stage	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
	<u>TOTAL MAN DAYS</u>												
I	19.9	19.4	38.7	62.7	48.8	30.2	48.6	38.3	39.6	67.3	62.0	34.5	510.0
II	27.0	23.7	35.3	63.1	62.5	38.6	53.4	41.9	42.6	83.0	85.4	43.2	600.7
III	44.7	26.8	36.6	83.7	61.5	26.5	37.4	25.7	26.5	82.9	90.6	48.9	591.8
IV	44.7	26.8	36.6	73.5	52.5	26.5	37.4	25.7	26.5	82.9	43.0	48.9	525.0
V	49.2	32.2	37.2	68.6	18.6	18.4	36.2	18.1	18.0	71.5	29.9	24.5	422.4
VI	49.2	32.2	37.2	68.6	18.6	18.4	36.2	18.1	18.0	23.5	29.9	24.5	374.4
VII	7	26.2	37.5	84.1	33.8	25.8	41.4	50.8	37.7	29.0	35.1	42.5	493.6

Note: The stages are defined as follows:

Stage I: Irrigated with a persian wheel using traditional practice and conditions with 150 per cent cropping intensity.

Stage II: Irrigated with persian wheel using HYV with necessary inputs and 150 per cent cropping intensity.

Stage III: Irrigated with pumpset using HYV technology with necessary inputs and 180 per cent cropping intensity.

Stage IV: Wheat Thresher and Corn Sheller with Stage III and 180 per cent cropping intensity.

Stage V: Tractors and Cane Crusher with Stage IV and 180 per cent cropping intensity.

Stage VI: Wheat Reaper with Stage V and 180 per cent cropping intensity.

Stage VII: Stage VI with 220 per cent cropping intensity.

Table 22: Men Days Per Acre Required For Selected Crops At Different Levels Of Mechanization In The Well-Irrigated Areas Of Punjab

Stage	Inten- sity of Cropp- ing (Per cent)	Wheat	Maize	Sugar- cane	Cotton	Gram	Kharif fodder	Rabi fod- der	Pota- toes	Moong Kharif Pulses	Average Man days for all crops over 10 acre farm
I	150	33.4	34.5	111.0	38.8	12.2	12.2	39.8	-	-	51.0
II	150	42.5	46.7	117.7	45.8	12.2	12.2	39.8	--	-	60.1
III	180	32.6	40.5	86.4	39.0	10.8	7.5	12.0	-	-	59.2
IV	180	25.8	34.2	86.4	39.0	10.8	8.5	12.0	-	-	52.5
V	180	18.1	28.1	66.4	28.8	6.9	4.0	9.8	-	-	42.2
VI	180	12.1	28.1	66.4	28.8	6.9	4.0	9.8	-	-	37.4
VII	220	12.1	28.1	66.4	28.8	6.9	4.0	9.8	70.0	5.5	49.4

the 1968/69 demand for human energy by 1.3 per cent in Maharashtra as compared to requirements for the same crop using traditional methods. The reduction in labour demand by pumpsets (the only mechanizing factor considered in 1968-69) was negligible, being only 0.2 per cent.

It was projected that by 1983-84 only 20 per cent of paddy, wheat, jowar and bajra are expected to be mechanically threshed, 5 per cent of the area tilled by tractors, and pumpsets will command 35 per cent of the irrigated area. However there will be an additional demand for human labour created as a result of growing HYV which will more than counterbalance the effect of mechanical power in reducing labour demand. By 1983-84, with the increase in acreage under HYV, demand for labour will increase by 6.8 per cent. Pumpsets will displace 0.6 per cent of the labour and power threshers and tractors 1.0 per cent and 1.3 per cent respectively. The net result will be overall increase in labour demand by 3.8 per cent. This can be seen from the Table 23:

The NCAER in a study examined the implications of tractorization for farm employment among other things.⁴⁸

The survey was conducted in the Wheat Zones of Punjab, Haryana and Uttar Pradesh, in the Rice Zones of Andhra Pradesh and Tamil Nadu and in the Central Zones which

48. National Council of Applied Economic Research, Implications of Tractorization For Farm Employment, Productivity and Income, Volume I, New Delhi, Rakesh Press, 1980.

**Table 23: Changes In Demand For Human Energy:
Effects Of New Methods Compared With
Conventional Methods**

(In million of man-days required per year)

Cumulative Introduction of Technologies	Maharashtra	
	1968-69	1983-84
1. Conventional	1546.5	1703.3
2. :1 with HYV	1566.9	1819.5
3. :2 with pumpsets	1563.1	1808.7
4. :3 with power threshers	-	1790
5. :4 with tractors	-	1767.2
Net change	16.6	63.9
Per cent Net Change	1.1	3.8

included Maharashtra and Gujarat. In the Central Zone tractorization was mainly confined to the districts where commercial crops such as sugarcane and cotton are extensively grown. The reference period for the study was 1977-78.

When a tractor is used a certain quantum of animal and human labour is necessarily displaced because of the difference in the speed with which land preparation operation is performed with it. Similarly, other operations such as application of fertilizers and pesticides, sowing, irrigation etc., can be performed with the help of tractor energy or animal labour. The NCAER Study therefore indicated the importance to identify the operations for which a tractor is employed to find out its impact on

human employment.

With the establishment of public bodies like the agro service centres and with private individuals primarily buying tractors for renting, many cultivators now utilise tractor services for carrying out various agricultural services. A sample of tractor users who utilize tractor services through renting was also included in the survey. Hence, per hectare employment of human labour (man days) was compared between Tractor Owners, Tractor Users and Bullock Farms on all farm sizes as can be seen from Table 24.

Table 24: Human Labour Input Per Hectare

State	(Man-days)		
	Tractor Owner	Tractor User	Bullock Farm
Punjab	75.5 (84.6)	78.9 (88.4)	89.3 (100.0)
Haryana	56.4 (84.4)	54.5 (81.6)	66.8 (100.0)
Uttar Pradesh	96.2 (73.3)	119.6 (91.1)	131.3 (100.0)
Tamil Nadu	195.0 (112.3)	177.8 (102.4)	173.7 (100.0)
Andhra Pradesh	82.6 (97.1)	68.3 (80.3)	85.1 (100.0)
Gujarat	61.6 (117.1)	55.8 (106.0)	52.6 (100.0)
Maharashtra	206.6 (153.5)	184.3 (136.9)	134.6 (100.0)
ALL STATES	110.5 (105.4)	105.6 (100.8)	104.8 (100.0)

Note: Figures In Brackets are indices: Bullock Farm = 100.

From Table 24 it can be observed that Tractor Owners as a group provided 5.4 per cent additional man-days of employment compared to bullock farms. Tractor-users,

employing 105.6 man-days on a cropped hectare, were also found to be providing 0.8 per cent more employment compared to bullock farms.

In certain states such as Punjab, Haryana, Uttar Pradesh and Andhra Pradesh tractor owners and users employed less labour per cropped hectare compared to bullock farms. For example, in Punjab, a tractor owned farm employed 75.5 man-days of human labour while a bullock farm employed 89.3 man-days of labour. Also, in these states the cropping intensity (see Table 25) is only marginally higher in tractorized farms than bullock farms. In fact in Haryana there is no difference in cropping intensity between tractor users and bullock farms and for tractor-owners it is only 1 per cent higher. Such factors seem to provide a case against mechanization. However, it must be remembered that we are dealing with all farm sizes and hence do not get a clear picture of the impact of tractorization on employment. When we proceed to a state-wise analysis by size of farm perhaps the positive impact of tractorization on employment will be more clear.

In the states of Tamil Nadu, Gujarat and Maharashtra tractorized farms employed more labour per hectare than bullock farms. In these States, the cropping intensity on tractorized holdings was also more. The cropping intensity of tractor owners, tractor users and bullock farms is presented in Table 25.

In Maharashtra, Tamil Nadu and Gujarat tractor owners

Table 25: Cropping Intensity (Per Cent)

State	Tractor Owner	Tractor User	Bullock Farm
Punjab	193 (105)	193 (105)	184 (100)
Haryana	165 (101)	164 (100)	164 (100)
Uttar Pradesh	193 (103)	189 (101)	188 (100)
Tamil Nadu	157 (117)	134 (100)	134 (100)
Andhra Pradesh	134 (110)	125 (102)	122 (100)
Gujerat	119 (114)	111 (107)	104 (100)
Maharashtra	175 (122)	167 (117)	143 (100)
ALL STATES	165 (111)	156 (105)	149 (100)

Note: Figures In Brackets are indices. Bullock Farm = 100.

have a fairly larger cropping intensity than bullock farms. In the case of tractor users also (with the exception of Tamil Nadu) the cropping intensity was higher than bullock farms. In Maharashtra for example, tractor owners had a 22 per cent higher cropping intensity and tractor users a 17 per cent higher cropping intensity than bullock farms. This resulted in more total employment on tractorized farms. The per hectare employment of labour was 53.5 per cent more in tractor-owned farms than in bullock farms and in the case of tractor using farms it was 36.9 per cent more. The employment intensity of crops differ widely. For e.g. the human labour required for sugarcane or potato is significantly different from that used for wheat or paddy. In

Maharashtra, tractorized farms have taken on to commercial crops like sugarcane which are labour-intensive and have thus increased per hectare labour employment.

In Gujarat too, tractor-owned farms have a 14 per cent higher cropping intensity and tractor using farms a 7 per cent higher cropping intensity than bullock farms. The employment of labour in tractor owned farms is 17 per cent more and of tractor using farms is 6 per cent more per hectare than bullock farms. The high cropping intensity accounted for more total labour employment on tractorized holdings in Gujarat. The cropping pattern resulted in higher per hectare labour employment. In Gujarat, the tractor-owned farms increased the area under commercial crops such as cotton which is a highly labour-intensive crop and hence increased employment.

In Tamil Nadu, only tractor owned households have a higher cropping intensity (of 17 per cent) than bullock farms. Also, the employment of labour per hectare was 12.3 per cent more. Again, the cropping pattern was another factor accounting for higher employment per hectare. Tractor owned farms took on to crops such as sugarcane, cotton and tapioca which required more labour.

Thus we find that in States such as Maharashtra, Gujarat and Tamil Nadu, the cropping intensity in most cases is significantly higher on tractorized holdings than on bullock farms and tractorization does not seem to have an adverse effect on employment.

The introduction of the tractor displaces labour for certain operations. However, tractorization when associated with improved and HYV technology and changes in cropping pattern results in more employment per hectare for certain other farm operations. It would therefore be interesting to examine the per hectare labour input by operations which is presented in Table 26.

Table 26: Per Hectare Human Labour Input (Mandays)

Operations	Tractor owner	Tractor user	Bullock farm
Ploughing	4.6	6.9	14.4
Manuring	2.6	1.7	2.3
Sowing	15.9	15.4	13.7
Irrigation	9.7	9.8	9.4
Fertilizer Application	5.4	3.9	3.4
Pesticide Use	1.4	1.3	1.7
Inter culture	25.3	24.2	19.5
Harvesting	30.2	27.2	24.1
Threshing	8.3	8.7	8.5
Transportation	7.4	6.6	7.5
TOTAL	110.5	105.6	104.8

From Table 26, it is observed that tractorized farms employ less number of persons only in ploughing. This is because the major purpose of the tractor is to plough the land. The tractor can plough the land much better and more

quickly than the wooden or iron plough and hence is used mainly for this operation. Human employment of tractorized farms and bullock farms is broadly similar in manuring, irrigation, pesticide use, threshing and transportation. Tractorized farms however employ more persons for harvesting, sowing, interculture and fertilizer application. As yield is generally higher on tractorized holdings, more labour is required for harvesting which is generally done purely by human labour, unlike threshing, where in some cases a thresher is used. Also, HYV seeds require more careful seed bed preparation, precise plant spacing and exact depth of planting to gain optimum yields. As tractorized holdings generally use HYV's to a larger extent than bullock farms, the labour input per hectare for sowing is higher. Again, tractorized holdings use more fertilizers than bullock farms and hence require more labour input per hectare for this operation. With heavy application of chemical fertilizers under improved and HYV technology, infestation of weeds become greater, since they also benefit from the fertilizer. Thus again more labour per hectare is necessary for inter cultural operations.

As mentioned earlier, the studies so far discussed on the impact of tractorization on employment does not consider individual farm sizes but only takes into consideration all farms. This may not reveal a proper picture of the impact of tractorization on employment. Hence a detailed state-wise analysis of the above study by size of farm was also

undertaken by the NCAER which provided the data base for the main findings, and the magnitude of variations in the impact of tractorization among the States studied.⁴⁹

However, only three states (one in each zone) have been discussed. These states are Punjab (wheat zone); Tamil Nadu (Rice Zone); and Maharashtra (Central Zone).

In these three States viz. Punjab, Tamil Nadu and Maharashtra, impact of tractorization on employment by farm size is analysed. Table 27 shows human labour employment per cropped hectare (in the three states) and Table 28 indicates the cropping intensity (in the three states) by size of farm.

In Punjab in the size of farm below 2 hectares, no differences were observed in cropping intensity between tractor owned and bullock farms but tractor owners employed 4.5 additional man-days per hectare than bullock farms. In the case of tractor users additional labour employed per hectare was 2.1 man-days although the cropping intensity was lower on tractor using farms than bullock farms. This is perhaps, because tractorized farms performed the operations more intensively than bullock farms. Also, in the case of tractor-owned farms, although labour was displaced for ploughing, it was more than counterbalanced by operations such as irrigation and harvesting.

49. National Council of Applied Economic Research, Implications of Tractorization For Farm Employment, Productivity and Income, Volume II, New Delhi, Bharat Mudranalaya, 1980.

Table 27: Human Labour Employment Per Cropped Hectare (Man-days)

	Farm size (ha)				
	Below 2	2-4	4-10	Above 10	All farms
Punjab:					
Tractor owner	82.6	84.5	74.7	74.3	75.5
Tractor user	80.2	79.2	83.4	74.3	78.9
Bullock farm	78.1	98.9	87.0	85.5	89.3
Tamil Nadu:					
Tractor owner	242.5	292.1	174.5	175.8	195.0
Tractor user	206.4	201.8	155.5	158.6	177.8
Bullock farm	220.8	196.5	126.7	-	173.7
Maharashtra:					
Tractor owner	298.3	188.2	199.0	219.7	206.6
Tractor user	204.6	221.8	209.0	130.2	184.3
Bullock farm	109.5	184.5	131.3	114.3	134.6

In size-group 2-4 hectares cropping intensity was marginally higher on tractor-owned holdings than bullock farms. The labour input per hectare was 14.4 mandays less in tractor-owned farms. This was again due to the ploughing operation which displaced labour heavily. While bullock operated farms used 42.4 man-days per hectare for ploughing, tractor owners used 1.9 and tractor users used 8.5 labour man-days per hectare.

In size group 4-10 hectares, we find that bullock-operated farms had a higher cropping intensity than

Table 28: Cropping Intensity By Farm Size (Per Cent)

	Farm Size (ha)				All farms
	Below 2	2-4	4-10	Above 10	
Punjab:					
Tractor owner	200	200	193	192	193
Tractor user	193	192	194	191	193
Bullock farm	200	196	200	148	184
Tamil Nadu:					
Tractor owner	175	168	151	180	157
Tractor user	158	166	123	111	134
Bullock farm	160	119	127	-	134
Maharashtra:					
Tractor owner	201	180	176	149	175
Tractor user	209	174	160	158	167
Bullock farm	144	166	139	135	143

tractORIZED farms and also employed more labour per hectare. This situation seems rather unlikely especially since tractorized holdings had a higher percentage of irrigated area than bullock farms and also their cropping patterns were more or less similar. The NCAER Study states that impact of tractor ownership or usage on cropping intensity is not clearly evident in the lower size group.

In Punjab, in the small and medium-sized farms we find only marginal differences in cropping intensity between tractorized and bullock farms. Since the size of the farm

is small, even bullock farms are in a position to utilise the land more intensely and thus increase cropping intensity.

However, in the case of large sized farms (above 10 hectares), it is observed that the cropping intensity in tractorized holdings (192 per cent) is significantly higher than the cropping intensity in bullock farms (148 per cent). The tractor helps in performing timely operations which helps to increase cropping intensity. In this case, although employment of labour per hectare is less on tractorized holdings as compared to bullock farms, total employment as a whole in the farm must have increased. This is because the extent of multiple cropping is much more on tractorized holdings.

In the case of Tamil Nadu we find that in all farm sizes the cropping intensity on tractor owned farms is much higher than bullock farms and so was the per hectare employment of labour. In the below 2 hectares farm size, cropping intensity on bullock farms was 160 per cent and on tractor-owned farms it was 175 per cent. The extra per hectare employment on tractor-owned farms was 21.7 man-days.

In the size-group 2-4 hectares, cropping intensity on tractor-owned farms was 168 per cent but on bullock farms it was 119 per cent. There was also a much larger employment of labour on tractor-owned farms (95.6 extra man-days per hectare).

Again, in medium farms, the cropping intensity and

per hectare labour employment was larger on tractor owned farms. Thus in the case of tractor owned farms, the effects of tractorization on employment seemed to be favourable.

In the case of tractor-using farms, there are marginal differences in cropping intensity in the case of most of the farm sizes. In 2-4 hectares however, the bullock operated farms had a cropping intensity of 119 per cent while tractor users had a cropping intensity of 166 per cent. The employment of labour per hectare was also more.

In Maharashtra too, the impact of tractorization on employment was favourable. In fact tractorization created more job opportunities. The cropping intensity in the case of small, medium and large sized farms was higher on tractor-owned farms as compared to bullock farms. The cropping intensity however showed a diminishing tendency with the increase in size of farm. In the size group - below 2 hectares cropping intensity was 201 per cent but in size group - above 10 hectares it was 149 per cent. The employment of labour per hectare on size group - below 2 hectares was 298.3 man-days and on size group - above 10 hectares was 219.7 man-days. In both cases the employment per hectare was significantly higher than bullock farms.

In the case of tractor users too, the cropping intensity as well as employment per hectare were larger than on bullock operated farms in Maharashtra.

One can therefore conclude from the tractor surveys

conducted that tractor use has not significantly reduced farm employment. The explanation for this phenomenon of non-displacement of human labour is the combined effect of more intense utilization of land, adoption of labour intensive crops and HYV seed based technology to a greater extent by tractorized farms. All these factors have paved the way for increased employment on tractorized farms.

In a study on Factors Influencing Labour Employment On Punjab,⁵⁰ Grewal and Kahlon examined whether tractor technology was labour saving or labour using. This was done by comparing labour input per unit area on bullock and tractor operated farms, as can be seen from Table 29.

Table 29: Labour Input Per Acre (Man-days) On Large Bullock-Farms And Tractor-Farms Punjab 1969-70

Crop Region	Labour Input		Reduction In Labour Input	
	Bullock operated farm	Tractor operated farm	Absolute	Per cent
Paddy	38.26	33.68	4.58	11.97
Groundnut	36.47	30.01	6.46	17.71
Cotton	27.33	27.90	-0.57	-2.49
Potato	66.74	99.32	-32.58	-49.11
Sugarcane	46.03	36.74	9.29	20.18
Average	37.72	38.46	-0.74	-1.96

50. Grewal, S.S., and A.S. Kahlon, "Factors Influencing Labour Employment On Punjab Farms", Agricultural Situation In India, April 1974.

Tubewell irrigation was common to both categories of farms, excepting cotton area, where the main source of irrigation was canal in both cases. The difference in the proportion of area irrigated on bullock and tractor-operated farms were insignificant. The comparison of labour use on tractor farms was made with large bullock farms because tractors were mainly introduced in this category of farms.

Table 29 indicates that labour employment in the potato region was distinctly higher than that of the other crop regions. The effect of tractor technology on labour use was different in different crop regions. There was no decrease in employment per acre in potato and cotton regions; rather there was an increase in labour input on mechanized farms, particularly so in the vegetable areas. This was due to the nature of crops grown in these areas. Excepting preparatory tillage and transportation, no other major operation was mechanized for these crops.

In the other crop zones there has been some decline in labour input on tractorized holdings. On the whole however there was an increase in per acre employment of labour on tractor-operated farms by 1.96 per cent. Over and above an overall marginal increase in per acre labour input, since the intensity of cropping by and large is higher on the tractor operated farms, the total employment on the tractor operated farm will be considerably larger than on the bullock operated farm.

Thus the use of tractors had no adverse effect on employment and the view point that tractor technology is labour saving has not been accepted.

A very small number of studies have been undertaken on the "Impact of Harvest Combines On Labour". This is probably because (i) the harvest combine is a relatively new addition to the mechanization stream in Indian agriculture, (ii) its use has been limited to only a few, though the most prosperous, pockets of the country. The studies indicate that the advantages of using harvest combines, as viewed by the individual farmer are: (i) it alleviates the acute harvesting labour scarcity problem (ii) minimizes risks, (iii) saves from drudgery and tensions, (iv) saves time and, (v) is cheaper. But although the use of a combine harvesters is beneficial to the individual farmer there is a social loss in terms of considerable labour displacement. Harvest-combines displace labour on a large scale and thus aggravate the problem of rural unemployment. Keeping in view the available labour potential and the social cost involved, the studies recommended that the use of harvest combines should be discouraged under the existing conditions in India.

Hanumantha Rao⁵¹ has discussed the relative costs

51. Rao, Hanumantha, C. H., Technological Change & Distribution of Gains in Indian Agriculture, Chapter 6, Institute of Economic Growth, The Macmillan Company of India Limited, 1980.

of traditional and mechanical methods of harvesting and threshing wheat. Traditionally, wheat is harvested by human labour and threshing with the use of bullocks as well as human labour. Mechanical threshing has become quite common, recently, in Punjab, Haryana and parts of Uttar Pradesh but harvesting is still done by human labour. The use of combine harvesters, which replace human and bullock labour for harvesting as well as for threshing, is also spreading gradually. Hanumantha Rao has compared the costs under three alternative techniques:

- (a) harvesting and threshing with human and bullock labour,
- (b) harvesting with human labour and threshing by mechanical thresher,
- (c) harvesting as well as threshing by mechanical methods, i.e. by using harvest combines.

His study concluded that 70 per cent of the cost of harvesting, threshing and winnowing wheat under the traditional method consists of labour input, so that the harvest combine - which displaces labour on a large scale - turns out to be the costliest from the social point of view. The private cost of traditional methods ranges from Rs.150 to Rs.185 per acre. From the private point of view, mechanical threshing or even the use of combine harvester - the cost of which ranges from Rs.106 to Rs.126 per acre - would thus be less costly than the traditional methods. Thus, the profitability of the mechanical methods, from the

private point of view, derives from the predominance of labour costs for these operations, which itself derives, in part from the high wage rates. Manual harvesting combined with mechanical threshing turns out to be the cheapest from the private as well as social point of view.

The above conclusions do not take into account the uncertainties faced by the farmers regarding the timely availability of hired labour. Nor do they take into account the risk of damage to the harvested crop from rain, etc. It is, thus, possible that the ex ante costs of traditional methods are much higher, which may explain why the large farmers prefer to go in for harvest combines despite the relative cheapness of manual harvesting-cum-mechanical threshing and despite the fact that the risk of damage to the harvested crop is considerably reduced when the mechanical thresher is used.

The main conclusion that emerged from Hanumantha Rao's study was that manual harvesting combined with mechanical threshing is the cheapest from the private as well as social point of view. The use of a harvest combine although cheap from the view point of a private farmer, resulted in great social loss because of its labour-displacing potential.

A study on the "Impact of Harvest Combines On Labour-Use, Crop Pattern and Productivity" (Rabi 1977-78 And

Kharif 1978)⁵² was undertaken at the instance of the Project Appraisal Division of the Planning Commission. The study was carried out mainly in Punjab and Haryana. But a small sample of farmers in Rajasthan and Uttar Pradesh were also covered.

The study considered the effect of Harvest Combines on employment in the survey area, by a comparison of two techniques viz., Harvest Combines (HC) and Intermediate Technology (IT) in the case of wheat and HC and Traditional Technology (TT) with regard to paddy. The effect of HC on the employment of different categories of labour viz., family, permanent, casual local and casual migratory labour, is discussed.

The mean labour days used for harvesting and threshing operations in the case of wheat and the labour displacement by HC is shown in Table 30 and Table 31 respectively for all districts in the survey area. They are given according to farm size group and labour category.

Table 30 shows that the average man-days per acre for wheat are just 0.50 for HC farms as against 9.29 for IT farms, (for all size-groups). There is thus, a displacement of 8.79 man-days per acre by HC or 95 per cent reduction in employment as compared with IT.

52. Laxminarayan, H., Gupta, D.P., Rangaswamy, P., and Malik, R.P.S., Impact of Harvest Combines On Labour-Use, Crop Pattern And Productivity (Rabi 1977-78 and Kharif 1978), Agricultural Economics Research Centre, University of Delhi, Research Study No. 79/3, Delhi, 1979.

Table 30: Mean Mandays Per Acre For Harvesting And Threshing Operations Under Harvest Combine (HC) And Intermediate Technology (IT) Wheat 1977-78

All Districts

Size-Groups (In Acres)	Mandays Per Acre Under HC					Mandays Per Acre Under IT				
	Family Labour	Permanent Labour	Casual Labour		Total	Family Labour	Permanent Labour	Casual Labour		Total
			Local	Migratory				Local	Migratory	
Upto 20.00	0.28	0.13	0.38	0.12	0.90	2.85	0.83	4.13	2.37	10.17
20.1 - 40.00	0.16	0.18	0.13	0.03	0.50	2.30	1.51	3.20	2.54	9.54
Above 40.00	0.13	0.21	0.09	0.02	0.45	1.63	1.65	3.03	3.22	9.53
TOTAL	0.15	0.20	0.12	0.03	0.50	2.16	1.43	2.95	2.75	9.29

Table 31: Labour Displacement Per Acre By Harvest Combine, Wheat 1977-78

All Districts

Size-Group (In Acres)	Family Labour	Permanent Labour	Mandays Displaced Per Acre		Total
			Local Labour	Casual Labour Migratory Labour	
Upto 20.00	2.57 (90.18)	0.70 (84.34)	3.75 (90.80)	2.25 (94.93)	9.27 (91.06)
20.1 - 40.00	2.14 (93.04)	1.33 (88.07)	3.07 (95.93)	2.51 (98.81)	9.05 (94.75)
Above 40.00	1.50 (92.02)	1.44 (87.27)	2.94 (97.02)	3.20 (99.37)	9.08 (95.27)
TOTAL	2.01 (93.05)	1.23 (86.01)	2.83 (95.93)	2.72 (98.90)	8.79 (94.62)

Note: Figures in brackets are percentages to man-days under intermediate technology. Intermediate Technology is one in which harvesting is done manually but threshing is done through a mechanical thresher.

The man-days per acre are higher for the first size group than for others under both techniques. It is 0.90 for the first group (upto 20.00 acres) as compared with 0.50 and 0.45 for the other two groups under HC. But under IT, this difference is relatively less. The man-days per acre are 10.18 for the first group, 9.55 for the second and 9.53 for the third. Though the extent of labour displacement in absolute terms is a little more for the first size group (9.27 man-days per acre) than for the other two (9.05 and 9.08 mandays per acre), in per cent terms it is less for the first group (91 per cent) than for the second and third (94.75 and 95.27 per cent respectively).

Regarding the composition of labour, we find that casual labour (local + migratory) is the major component under IT, forming about 61 per cent of the total man-days. Under HC however, the share of casual labour is reduced to just 30 per cent of total man-days. The displacement of casual labour is at the rate of 5.55 man-days per acre. Among casual labour, local labour is displaced by 96 per cent and migratory labour, by 99 per cent (all size groups). So casual labour is practically eliminated under HC. Family labour is displaced at the rate of 2.01 days per acre or 93 per cent, while permanent labour days are reduced by 1.23 days per acre, or 86 per cent of its employment under IT.

In Tables 32 and 33 respectively, the man-days and

Table 32: Mean Labour Days For Harvesting And Threshing Operation Under Harvest Combine And Traditional Technology, Paddy-1978.

Size Groups (In Acres)	Man-days Per Acre Under HC					Mandays Per Acre Under T.T.				
	Family Labour	Permanent Labour	Casual Labour		Total	Family Labour	Permanent Labour	Casual Labour		Total
			Local Labour	Migratory Labour				Local Labour	Migratory Labour	
Upto 20.00	0.26	0.21	0.12	0.009	0.62	3.03	1.34	5.75	8.86	19.00
20.01 - 40.00	0.34	0.26	0.08	0.06	0.76	2.12	1.26	2.54	10.87	16.80
Above 40.00	0.35	0.48	0.08	0.008	0.92	1.72	1.98	6.52	9.41	19.64
Total	0.34	0.41	0.08	0.02	0.85	2.10	1.58	4.82	9.89	18.39

Table 33: Labour Displacement Per Acre By Harvest Combine, Paddy 1978

Size-Group (In Acres)	Man-days Displaced Per Acre				
	Family Labour	Permanent Labour	Casual Labour		Total
			Local Labour	Migratory Labour	
Upto 20.00	2.78 (91.41)	1.12 (83.58)	5.64 (97.91)	8.85 (99.89)	18.39 (96.79)
20.01 - 40.00	1.78 (83.96)	1.00 (79.36)	2.46 (96.85)	10.81 (99.44)	16.05 (95.59)
Above 40.00	1.37 (79.65)	1.50 (75.75)	6.44 (98.77)	9.40 (99.91)	18.71 (95.32)
Total	1.76 (83.80)	1.17 (74.05)	4.75 (98.34)	9.87 (99.79)	17.54 (95.38)

Note: Figures In Brackets are percentages to man-days under traditional technology.

the displacement per acre under harvest combine as compared with traditional technology are presented, in the case of paddy.

Since it is traditional technology that is in vogue with regard to harvesting and threshing of paddy, and no threshers are being used, as in the case of wheat, labour displacement by HC is even higher (in absolute terms) for paddy than for wheat.

The mean man-days per acre are 18.39 under TT and 0.85 under HC (for all size-groups). So the rate of displacement by HC is 17.54 man-days per acre or 95 per cent of labour days under TT.

Size-wise distribution for all districts, shows that for the first size-group, the percent of displacement is a little more (97 per cent) than for the other two groups, but in absolute terms, displacement is highest in the case of the third group (18.11 man-days per acre) closely followed by the first (18.39 man-days per acre).

The composition of labour shows that casual labour days form 80 per cent of the total labour days under TT. This is reduced to a mere 12 per cent under HC. On the other hand, the share of family and permanent labour, which is only 20 per cent under TT is substantially raised to 87 per cent under HC. Casual labour is practically eliminated under HC. The rate of displacement is 4.74 days per acre in the case of casual labour, which means a reduction of 98 per cent in its employment. In the case

of migratory labour, displacement is at the rate of 9.9 man-days per acre or 99.8 per cent of its employment under TT. Family labour is reduced by 1.76 man-days per acre or 84 per cent and permanent labour by 1.17 man-days per acre or 74 per cent of employment under TT.

The survey thus concluded that the major social cost in the use of HC is its high labour displacement effect. HC leads to about 95 per cent cut in employment, most of which is hired labour. HC leads to a practical elimination of migratory labour coming from labour surplus areas, which means blocking of avenues of employment for them outside their state.

4.3 Tractorization And Indirect Employment:

The use of mechanical devices in agriculture creates employment opportunities in their manufacture, distribution, finance, insurance and maintenance. With the growth in the use of tractors, a number of service and repair shops have been established particularly in areas where the tractor population is sufficiently large. Employment opportunities are also available in the manufacturing and distribution sectors. The NCAER study reported that the 11 tractor manufacturing units employ about 15,000 persons. Tractor manufacturers also buy a number of parts and components from ancillary units, which are reported to have employed 160,000 persons. Besides, tractor manufacturers have established 1,200 authorized dealers in the country to distribute the tractors. This information

enables us to conclude that tractorization generates indirect employment.

In light of the above discussion it can be concluded that insofar as mechanization is confined mainly to the use of tractors and irrigation pumpsets, there seems to be no adverse effect on employment. However, if mechanization is extended to the use of appliances such as harvest combines, there will be a social loss in terms of considerable labour displacement which will aggravate the problem of rural unemployment.

CHAPTER VOTHER EFFECTS OF FARM MECHANIZATION

The change from labour^{iv} to capital-intensive methods of production in the agricultural sector is one of kind rather than degree. The new methods of production have signalled the beginning of a transformation of agriculture from an impoverished "way of life" to a profitable business occupation.⁵³ Since mechanization has brought about such a radical change in farm operations, it is necessary to study its economic and social consequences. While the effect of mechanization on employment was discussed in Chapter IV, an attempt has been made in this chapter, to examine very briefly the other effects of farm mechanization.

5.1 Mechanization And The Use of Draft Animals:

Mechanization has had a significant negative effect on the use of draft animals. Mechanization of irrigation operation significantly reduced employment of draft animals. Similarly the introduction of tractors also resulted in a sharp reduction in the use of bullocks on tractorized holdings.

Tractorization has primarily affected the operations of preparatory tillage, sowing and transport. In fact, it

53. Frankel, R. Francine, India's Green Revolution: Economic Gains And Political Costs, p13, New Jersey, Princeton University Press, 1971.

was mainly these operations which required the use of draft animals. Tractor introduction has virtually eliminated the use of animal power in these operations.

The NCAER study on tractorization indicated that a tractor owner employed 2.8 pairdays of bullock labour (in addition to the tractor), a tractor user employed 6.6 pair days and a bullock farm employed 16.5 animal pair days on a cropped hectare.⁵⁴ In many states operations like interculture are continued to be done with animal labour even after purchase of a tractor by the farmer. Hence most tractorized holdings maintain a minimum stock of draught animals.

An important aspect in replacing the bullocks with machine-power is of saving the land that goes under fodders for draft animals. Also, there exists a competitive relationship between breeding the animals for draft purposes and for milk purposes. The more we gain on draft, more we have to loose on milk and vice-versa. The dual-purpose animals cannot be the ideal milk-yielders and have an excellent draft power at the same time. With efforts directed towards breeding the animals for milk purposes alone, it is far easier to develop high milk yielding breeds. Thus, a substitution of the draft animals with machines helps to improve the milk yields.

54. National Council of Applied Economic Research, Implications of Tractorisation For Farm Employment, Productivity And Income, Volume I, New Delhi, Rakesh Press, 1980.

At the same time, the resources being used in raising the draft animals get released and can be used for raising the milch animals.⁵⁵ Also, the opportunity cost of land is very high and if the fodder requirements are reduced through replacement of draft power by mechanical power, land can be used for production of foodgrains or commercial crops.

5.2 Tractorization, Productivity And Net Returns:

Most studies reported that tractorized holdings obtained higher yields than bullock farms in all the major crops grown by them. This was mainly because tractorized holdings use better seeds and larger doses of chemical fertilizers which have a direct effect on the yields.

Besides higher average yield on tractorized farms, the net returns per hectare on tractorized farms were also higher. This is presented in Table 33.

Net returns of an average tractor owner on a cropped hectare exceeded that of bullock farm by 152 per cent. A tractor user derived a net additional income of 84 per cent more than that of bullock farms.

Tractor owners and users spent more on material inputs and hired human labour. For instance, the expenditure of tractor owners on material inputs (seeds, fertilizers, irrigation) was 57 per cent higher than that of bullock

55. Johl, S.S. "Mechanization, Labour Use And Productivity In Agriculture", p40, Studies In Agricultural Capital and Technology, Occasional Paper No. 23.

**Table 33: Cultivation Cost And Net Returns
Per Cropped Hectare (Rupees)**

Costs	Tractor Owner	Tractor User	Bullock Farm
Material Inputs	865	745	552
Tractor	485	251	NIL
Animal Labour	316	488	846
Hired Human Labour	589	459	363
TOTAL	2,255	1,943	1,761
GROSS INCOME	3,970	3,196	2,442
NET RETURNS	1,715 (252)	1,253 (184)	681 (100)

Note: Figures in brackets are indices. Bullock Farm = 100.

Source: Implications of Tractorization for Farm Employment, Productivity and Income Volume I, NCAER, p96.

farms which to a large extent explained higher gross income obtained by them.

5.3 Changes In Land Utilization:

The changes that have been reported in this respect are:

(1) Change In Cultivated Holdings:

Investment in a tractor may provide an inducement to increased the size of the operated holding. This is mainly for better utilization of the machine or for spreading the fixed costs involved over a larger product. Increase in the holding size can be brought about by leasing in, purchase of additional land, reclamation of waste land or by more intensive use of available lands.

(ii) Changes In Multiple Cropping:

Tractorization makes double and multiple cropping possible mainly due to the increased speed of various operations in cultivation and the resulting economy in time needed for a particular operation. For instance, the time available to prepare the soil efficiently in order to sow at the right time is usually short. For the kharif season all ploughing with bullocks must be done between the pre-monsoon showers which soften the earth and the monsoon proper which flood the fields. With a tractor, ploughing can be done even before the pre-monsoon rains, so that, the period for preparing the soil is lengthened and enables a more thorough job to be done.

(iii) Changes In Cropping Pattern:

Introduction of a tractor can be expected to make an impact on the crop pattern. By displacing the bullocks, tractorization reduces the demand for crops like wheat, jower which produce fodder and enable the farmer to increase the area under crops like cotton and groundnut which are highly remunerative but which give little or no fodder.

5.4 Changes In The Cultural Practices:(i) Green Manuring Practices:

Many cultivators reported that the introduction of tractors enabled them to green manure their fields. The speed with which the tractor operates has made this possible. Sun-hemp, which is used for green manuring, is

sown in the month of July and is ploughed-in in the month of September. Before the purchase of tractors, the months of June and July were a period when the labour force was occupied fully for the preparation of the soil for kharif crops and hence sowing of sun hemp could not be undertaken. Ploughing-in of this manure is also a very labour-intensive operation. The green manure has to be cut, the land has to be ploughed and the manure has to be ploughed in. A tractor can do this job at one quarter of the time required by bullocks. Further it does not need any human labour except that of a driver. Thus tractorization encouraged raising of sun hemp which check the growth of weeds.

(ii) Ploughing Practices:

The tractor has enabled the farmers, whose land becomes very hard during summer, to plough their lands regularly. Ploughing of hard soil was difficult with an iron or bullock plough but was made easy with the use of tractors.

5.5 The Destiny of Tenants, Share-Croppers And Small Farmers:

One of the undesirable effects of mechanization is that sharecroppers may lose their tenure and become farm labourers. The exodus of large number of this farm proletariat will be part of the process of modernization of farming and of social change connected with farms.

Modern methods of farming are mainly developed on large farms. One way to establish large mechanized farms

was the change from tenancy to self cultivation. Many large farms were not managed as economic units before mechanization but were rented out in small plots. When landholders changed over to "self-cultivation" the sharecroppers were dismissed.

The new technology has also greatly enhanced the productivity of irrigated land and made capital accumulation in soil and water profitable. Profitable farms will tend to expand by acquisition of more land. The small unprofitable farms will thus be squeezed out of existence. Also, the profitable farms will make greater use of labour-saving machinery. Expansion of farm size by acquisition of more land and mechanization are complementary processes. The two will go hand in hand and will result in greater inequalities in agriculture.⁵⁶

5.6 Psychological Factors And Social Consequences:

Technological change meets a number of psychological barriers, but has also some very desirable effects on the people concerned. The highest barrier is formed by the old customs and habits, inherited from times immemorial. They arouse the fear of new debts and burdens too cumbersome for an indebted Indian cultivator.

Tractors and pumpsets are the first steps in a long chain of technological inputs, changing internal

56. Dandekar, V.M., and Nilkantha Rath, Poverty In India, p71-72, Pune, Sangam Press, 1971.

organization and outlook of agriculture. Once technological progress is initiated and accepted, there are a number of desirable effects. Some heavy operations are executed more easily and in a shorter period without stress. The value, the evaluation and the consciousness of man will increase in step with performance and responsibilities. A certain social promotion starts, and a group of qualified technicians emerges.

Thus a stagnant society is to a certain extent broken up and moved by new techniques. Lethergy or apathy is superseded by mobility. The compulsion of technology affects production techniques, hitherto held back in a self-sufficient economy with low inputs and small output.

It therefore appears that mechanization influences the whole farming pattern. The cultivator is compelled to drop his mainly subsistence economy, if he wishes to participate in technical progress. He has to buy fuel and pay interest for a costly machine. If he removes draught animals and uses tractors instead, for major farm operations, he can produce more marketable surplus and cash crops. Mechanization will, thus, break up the self-sufficient, autarcic village community and tie agriculture closely with the market.

CHAPTER VICONCLUSIONS

The study was undertaken with a view to examine the extent to which farm mechanization has spread in India and the factors responsible for its spread. The use of mechanical appliances, in agriculture, has often been cited as an example of an unemployment inducing change in technology in developing countries like India. Therefore, the study also examined the impact of various types of mechanization on employment and explained to what extent the new technology is labour using and to what extent it is labour saving. Finally, the other effects of mechanization such as its changes in land utilization, cultural practices, social changes etc. were considered.

From the study it can be observed that Indian agriculture has experienced steady changes in the transformation from traditional to more capital intensive farm technology since the mid-sixties. One finds a marked increase in the number of tractors, electric pumps and diesel engines. This phenomenon is particularly marked in the northern regions comprising the states of Punjab, Haryana, Western U.P. and in the southern states comprising the deltaic rice belts of Tamil Nadu and Andhra Pradesh, where factors were conducive to mechanization. Farm mechanization has spread noticeably in these parts of the country but in the overall context, it is still

an emerging phenomenon. The latest introduction in the process of farm mechanization which came about in the early seventies was the harvest combine. It was again more popular in Punjab and Haryana where conditions of labour scarcity especially in the harvesting season were observed.

The study on the effects of mechanization on employment indicated that mechanization of irrigation operations, through installation of pumpsets and tubewells and the use of electricity for irrigation, resulted in improved technical efficiency and increased employment although it displaced bullock labour. In labour-scarce and high wage areas, tractor cultivation associated with HYV technology, encouraged more intensive cropping, did not reduce the overall requirement for human labour and permitted timely agricultural operations over a large area. Thus, to this extent mechanization did not lead to displacement of labour. However, the introduction of harvest combines as a logical corollary to the introduction of tractors and tubewells resulted in severe labour displacement. Thus unrestricted mechanization does at some point begin to adversely affect employment and equity. Indiscriminate mechanization of agriculture may not be to the socio-economic advantage of the agricultural sector at this stage of our economy faced with a serious rural unemployment problem. Indian agricultural policy therefore advocates "selective mechanization." Mechanization

that expands productivity but does not displace labour is needed in India.

Most farms in India are small, which are not resourceful enough to purchase and operate improved implements and are confronted with the problem of indivisibility of machines. To overcome these difficulties - financial, technical and economical - of such farms, the collective use of machinery should be practiced rather than individual ownership. This could be done through co-operative societies, machine and tractor pools and arrangement between neighbouring farms. Also, considerable emphasis should be laid on the establishment of agro-service centres, in view of the need to ensure that the benefits of mechanized farming, reach to small and marginal farmers and they take to cultivation of HYV's. The agro-service corporations apart from hiring tractors, must also undertake repairs and maintenance, supply of spare parts etc. Loans from institutional credit agencies may have to be biased in favour of purchase of tractors by associations of farmers, panchayats, joint purchase by a few farmers and technicians who would like to start custom service for farmers.

Attention must also be paid to developing the infrastructure of the economy which is an important prerequisite to mechanization. The types of infra-structure required are:

(1) Social Overheads: Items which the farmers cannot

afford to provide, but which are essential aids, direct or indirect, for farm mechanization, e.g. power, roads etc.

(ii) Extension And Training Institutes: Agencies for the dissemination of knowledge and formation of non-traditional skills in the rural areas must be set up. The dissemination of the techniques must be done on a group basis, in view of the large number of farmers involved.

Rural development planning, therefore, should be given a new orientation to accommodate the trend towards increasing farm mechanization.

With respect to combine harvesters which tend to displace labour on a large scale, there should be a general reluctance to promote this type of mechanization except in areas where acute labour shortage in the harvesting period is felt. A study on harvest-combines indicated that for the solution of the labour problems of big farmers, efforts should be made to ensure an organized flow of labour force from labour surplus areas of Eastern U.P., North Bihar etc. to labour scarcity areas of Punjab and Haryana in order to remove the imbalance in supply and demand for labour during the harvesting seasons in these areas. If organized properly, this flow of labour can function well and to the advantage of both i.e. big farmers of Punjab etc. and surplus labour of Eastern U.P. and North Bihar at least till other employment opportunities are created for surplus labour in their own areas.

It is only after these employment opportunities are created and there are real labour scarcity conditions in labour deficit areas that switch to harvest combines should be encouraged.⁵⁷ At present however loans should not be given for the purchase of these machines and the agriculturalists concerned must be in a position to purchase out of their own funds.

On the whole however, it seems that the new technological advances have made owners-cultivation in sizable farms a distinctly profitable proposition. This must be regarded as a socially desirable development. Such farms may be regulated by registering them as farm businesses and bringing them under suitable labour and taxation laws. But subject to such regulation and within the limits of accepted ceilings they must be allowed to grow. They will grow by absorbing small uneconomic holdings and by mechanization of their operations. This should be regarded as legitimate and desirable because it will lead to an organization of agriculture into not only viable but profitable units with capacity for capital accumulation and development.⁵⁸ This will no doubt lead to an increase

57. Laxminarayn, H., Gupta, D.P., Rangaswamy, P., and Malik, R.P.S., Impact of Harvest Combines on Labour Use, Crop-Pattern And Productivity (Rabi 1977-78 and Kharif 1978), p170-171, Agricultural Economics Research Centre, University of Delhi, Research Study No. 79/3, Delhi, 1979.

58. Dandekar, V.M., and Nilkantha Rath, Poverty In India, p95, Pune, Sangam Press, 1971.

in the number of landless. Hence, attempts should be made to develop other opportunities for employment such as development of small-scale industries which are more labour-intensive and employ more direct labour per unit of capital. Also subsidiary activities such as raising poultry, farm forestry etc. should be undertaken. Rural works programme and employment guarantee scheme should also help to solve the problem of rural unemployment. These problems are however not quite germane to our discussion.

Summing up, it appears that in the short-run India has to follow a policy of selective farm mechanization which increases output but does not displace labour. In the long-run when spread of intensive agriculture and faster growth of non-farm employment materialise, mechanization of agriculture, which is a concomitant of overall economic development, is bound to make rapid progress.

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