CHAPTER 1

INTRODUCTION
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Indian agriculture has experienced rapid changes in some parts of the country. It is undergoing transformation from traditional to more capital intensive farm technology. The growth in agricultural production, to a large extent depends on innovations in technology of production. It is the new techniques of production which make higher productivity possible and thus result in higher per capital income for the people. In agriculture, there are several innovations which are conductive to higher productivity both of land and of individual. The more important among them are in irrigation, and use of improved seeds, fertilizers and pesticides. Apart from these, mechanization of agriculture has proved to be another important technological innovation for increasing the per capita productivity of agricultural occupation. Generally, its main advantage has been thought to be enabling the agriculturists to put much more area under crop than

   Sadhu & Mahajan: "Technological change and Agricultural Development in India."

   Sadhu D. S. & Singh A. J. : "Technological Change in Indian Agriculture." Indian Agricultural Development since Independence P. 141
is possible with the help of animal traction power. Thus, mechanization played a crucial part in increasing per capita productivity.¹

Farm technology may be distinguished from farm mechanization and farm technical knowledge. Farm mechanization refers to the use of mechanical power while technical knowledge refers to the knowledge of using a technology in farm operations.² Mechanization of agriculture and farming process cannot be application of machine power to work on land, usually performed by bullocks and other draught animals or by human labour.³

Mechanization is often taken to mean tractor cultivation.⁴ Tractorization in labour surplus countries such as India, is a much debated issue.⁵ One School of thought advocates increasing use of tractors as they facilitate


multiple cropping and expose rural people to a technology based modern product. The other group holds that tractors are inappropriate in India as they are Capital intensive and labour displacing.¹

The advent of intensive cultivation² and the introduction of High-yielding varieties of seeds (HYS) have increased the demand for tractors³. A major feature of many of the new seeds (HYVs) is their shorter maturing period, which makes possible the cultivation of two or more crops in a year.⁴ As stated "The possibilities of double cropping have been made more feasible by the new genotypes, which have a shorter growing period than traditional varieties do."⁵ With the introduction of high

investment, intensive agriculture and multiple cropping, it has become essential to ensure timely farm operations of satisfactory quality that can only be achieved by using efficient and well adopted machinery and implements.\(^1\) The traditional farm equipments and practices were found inadequate to cope with the requirements of new situations. This paved the way for mechanisation. In the areas where High yielding Varities programme has taken root, one observes more use of tractors.\(^2\) The use of tractor saves time and enables a particular agricultural operation to be completed within a given time limit which bullocks farming can not achieve.\(^3\)

Tractors were introduced to Indian agriculture in the early twenties.\(^4\) Tractor farming is more concentrated in Punjab, Haryana and Western districts of Uttar Pradesh, where


4. The Economic Times: "Are Tractors Relevant" (Indian Agriculture) May-21, 1979, P 1-8
adoption of the HYV technology has increased in crop yields.¹ Tractors are used mostly for ploughing, threshing and transport.² They can be used for seed-bed preparation, row showing, manuring, interculture and for providing power to the irrigation pump, the reaper, the thresher or the combine.³

Tractors are used in agriculture because they have many advantages over bullock cultivation. Some of them are given in the following paragraphs.

The tractor is used because it increases the speed of farming operations and performs agricultural operations timely. Many of the major crop operations in India are some what rigidly bound by the season. The time available to prepare the soil efficiently in order to sow at right time is usually short. On the other side, the advent of new


3. Agrawal, Bina: "Mechanization in Indian Agricultural" 1983, P. 6
seeds (HYVs) with their shorter maturing period makes possible the cultivation of two or more crops in a year and create a bottleneck. The tractor has facilitated the ploughing of maximum area at appropriate times, during very short wet periods. It has been estimated that "A pair of bullocks on an average can cultivate 6.33 acres of crops in a year in West Bengal." The use of a medium sized tractor in place of the pair of bullocks would therefore enable the cultivation of 101.28 acres, or roughly 100 acres of crops in a year."

Another study in Punjab indicated that "6.8 hours of tractor time replaced 46 bullock hours and 37.7 man hours."\(^2\)

Tractor ploughing is easier with heavy soil and particularly in dry season when soil becomes hard. According to D.R. Bomford, "The ploughman with his three-horse team controlled three-horse power, when given a medium sized crowler tractor controlled between 20 to 30 horse power."\(^3\)

A study in Andhra Pradesh indicated that "the percentage of farmers using tractors increased from 84 percent during the rainy season to 93 percent during the dry season."\(^4\)

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Tractorization modifies social structure in rural areas. Traditional agriculture involves hard work and drudgery. But tractorization frees the farmers from this drudgery and allows them to enjoy more leisure and work under agreeable conditions. According to Hanumantha Rao, "It may even raise the participation rate among those who could afford to abstain from drudgerous manual work." It also saves the trouble of rearing bullocks, finding them pastures and managing them in muddy fields.

Tractorization results in lower cost of work and is beneficial. "The cause of the increasing use of tractors in Punjab and Haryana is due to the fact that this machine is relatively cheaper input." As estimated by Mrs. Mehroo Jussawala, the cost of tractor farming with one 40 H.P. tractor is less (Rs. 41520) as compared to the cost of bullock farming with 40 pairs of bullocks of equal 40 H.P. (Rs. 65200). An estimate in West Godavary indicated a

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Saving of Rs. 396 per hectare by introducing tractors and further a net benefit of Rs. 266 per hectare for tractor owners and users in the rice zone.¹

Tractorization results in better use of land and the rents for their services are not always higher than those of the bullocks. It can dig deeper and bring to the surface more fertile soils and contribute to greater productivity. Parthasarthy² calculated the rents for ploughing one hectare of land with tractor and bullocks to be Rs. 75 and Rs. 86 respectively where as the rates for bullocks were cheaper when used for threshing (Rs. 37 and Rs. 30 respectively), more than 90 percent of farmers used tractors because of the belief in their superiority over bullocks in this operation.

Tractorization increases the efficiency of labour as well as land and therefore, raises agricultural production

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per unit of land and per worker. A number of field studies\(^1\) (viz Huns. P. Binswanger, Kahlon, A.S., Singh & Singh, and Kahlon, Miglani & Mehta etc.) were conducted to establish the relationship between tractorization and productivity and they found that there was higher yield per acre/hectare on tractorized farms as compared to those of bullock farms.

It is also observed that tractorization increases the cropping intensity. With the help of tractor, farm operations can be completed in much less time than if they are to be performed manually as well as bullock power. In the words of I, Arnon,\(^2\) "the possibility of

\begin{itemize}
    \item Singh, Roshan & B.B. Singh \textit{Form Mechanization in Western U.P.} Problems of Farm Mechanization Seminar Series, IX, Indian Society of Agricultural Economics, Bombay 1972.
    \item Kahlon, A.S. Miglani & Mehta \textit{Studies in Economics of Farm management Ferozepur District(Punjab) Report for the year 1969-70,Directorate of Economics & Statistics Ministry of Agriculture, Govt. of India (Mimeographed) 1974.}
    \item Arone, I \textit{Modernization of Agriculture in Developing countries.} John Wiley and Sons, New York. 1981.
\end{itemize}
replacing one-crop a year production pattern by multiple cropping is dependent on a shortening of the time involved in freeing the field from one crop and preparing it for the next one. This usually depends on the possibilities of mechanizing certain operations such as harvesting, threshing, land preparation etc. There are several studies have indicated higher cropping intensity on tractorized farms than the bullock-operated farms.

A tractor owner may increase his household income by undertaking supplementary activities such as dairying and provision of custom services. A tractor owner with a land holding of 6.28 hectares, has an average gross income of Rs. 47534 which exceeded that of a bullock farm by 285 percent. A tractor-owner, with a land holding of 2-4 hectares is able to increase his household income to a level comparable to that of a bullock farm with a holding of 10 hectare and more.

Tractorization generated non farm employment in the manufacture, distribution, repair and maintenance of tractors. It also generates indirect employment through the multiplier effect


Johl, S.S.: "Mechanization, labour use and productivity in Indian Agriculture." Economics and Sociology, occasional paper, No. 23 Ohio State University Columbus, 1970.


It is said that tractor-owners as 'gentlemen farmers' are more advanced than the bullock-farmers and the tractor has become status symbol for them. In agriculturally backward areas they use tractors in transportation for carrying fertilizers, seeds, crops and even people. It has become a more powerful source of earnings than the agriculture.

Tractor cultivation is restricted in many parts of the country because:

1. Most of the holdings are irregular in shape and uneconomic. More than 50 percent holdings are below 1 hectare, while tractorization is economical in large size holdings.

2. Tractor is not suitable in all conditions, specially for the ploughing of the corners of the fields at least one pair of bullocks is needed by the cultivators.

3. Tractorization has very limited scope in India due to acute problem of unemployment, the use of tractors

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in agriculture will create this problem. Empirical studies have shown that tractor is a labour displacing machine.

4. There is an acute shortage of kerosen petroleum and diesel oil in India. These need to be imported from abroad at a high cost and this leads to a heavy drain on foreign exchange reserves. Thus, the use of petrol or diesel oil makes tractor very costly.

5. There is also a lack of mechanical skill in the country. The farmers are not aware of the use of even simple mechanical appliances and the result is that they do not operate tractors with full efficiency.

6. There is the inadequacy of workshops, fuel supply stations, supply of spare parts, repairing facilities and servicing stations in the country except in agriculturally developed areas.


OBJECTIVES OF THE STUDY:

The basic objectives of the study are:

1) To find out the impact of tractorization on productivity per acre of paddy crop.

2) To analyse the impact of tractorization on human labour employment per acre.

HYPOTHESES TO BE TESTED:

We have formulated following two hypothesis and have tried to test their validity.

1) That tractorization in farming increases yield per acre in comparison to the bullock-operated farms and

2) That tractorization displaces the human labour and therefore, the human labour employment less in tractor operated farms as compared to the bullock-operated farms.

RESEARCH METHODOLOGY:

The study is based on primary data. To find out the impact of tractorization on farm employment and productivity, we have taken 60 samples each from tractor-owning and bullock-operated farms of Raipur District. Multistage sampling is used to select the samples. At the first stage of sampling, we have to select that tahsil which has the maximum number of tractors. At the second stage, we have to select that block which has the maximum number of tractors in the selected Tahsil. From the selected block,
we have to select those villages which have atleast three tractors and from these villages we have to select the sample farmers using stratified random sampling technique.

In Raipur district, 1428 tractors were used during the year 1986-87. Out of them a maximum of 380 tractors were found in Raipur Tahsil and out of them a maximum of 89 tractors were used in Dharsiwa block. Therefore, we selected Dharsiwa block as a sample block in our study. In the block, we have selected those villages where three or more tractors are used. Thus, 17 villages are selected for the study. In these villages, 60 tractor-owning farmers and an equal number of bullock-using farmers are selected.

Relevant data such as the size of holdings, cropped area, cropping pattern, area irrigated, area under high-yielding variety seeds, fertilizer consumption, production, yield (per acre) as well as human labour employment are collected through personal interview using pre-tested schedules. The reference period of the study is 1986-87 (agricultural year). The period of the survey was January to March of the year 1987. During the survey it was observed that all the sample farmers were using HYVs, chemical fertilizers and pesticides. They had irrigation facilities also. Though the sample farms of two types were not identical, they had close similarity regarding the size of holdings. Also, they represent the basic characteristics of the farmers of the district.
Here it is important to note that the Raipur District is a monocrop region where, paddy is the main crop. Therefore, we have considered only paddy crop in our study.

**Analytical Techniques:**

For analysis of the data, first of all, we have classified all the sample farmers into three categories viz., small size farmers (below 10 acres), medium size farmers (10-25 acres) and large size farmers (25 acres and above). Percentage method is used to find out the cropping intensity (dividing total cropped area by net sown area), the area irrigated and the area under HYVs. Weighted arithmetic average is calculated to find out the yield per acre as well as the human labour employment per acre in the tractor and bullock-operated farms. We have tested our hypothesis and also computed multiple regression analysis with dummy variable, to find out the net impact of tractor and other important factors on productivity and the human labour employment per acre separately.

**'F' Test:**

To test the significance of variation in productivity and human labour employment per acre separately in tractor-owned and bullock-operated farms, we have used the analysis of variance with only two groups. The productivity/human labour employment per acre in tractor-farms is considered as group 1 and the productivity/human labour employment per acre in bullock-operated farms is considered as group 2.
The following formula is used:

\[ F = \frac{MS_b}{MS_w} \text{ or } \frac{\text{Mean Square for between groups}}{\text{Mean Square for within groups}} \]

We have also applied two-way classification analysis of variance taking the productivity/employment per acre in tractor and bullock farms as factor 1 and size of holdings (viz, small, medium and large size) as factor 2. The following equations are used:

1. \[ F = \frac{MS_{f1}}{MS_w} \]
   
   Where -
   
   \[ MS_{f1} = \text{Mean sum of square for factor-1 (Tractor & Bullock)} \]
   
   \[ MS_w = \text{Mean sum of Square within the groups.} \]

2. \[ F_1 = \frac{MS_{f2}}{MS_w} \]
   
   Where -
   
   \[ MS_{f2} = \text{Mean sum of Square for factor 2 (Size of holdings)} \]

3. \[ F_2 = \frac{MS_{1x2}}{MS_w} \]
   
   Where -
   
   \[ MS_{1x2} = \text{Mean sum of Square for Factor 1 and Factor 2.} \]
REGRESSION ANALYSIS:

We have used a multiple regression (Linear) analysis on a cross section of farms to explain the variation in productivity and human labour employment per acre. We have also used a dummy variable (which has a value of 1 if tractors are owned and 0 otherwise) to measure the net impact of using tractors instead of bullocks.

PRODUCTIVITY MODEL:

Productivity depends upon many factors or inputs which are used in agriculture. To find out the impact of various factors affecting the productivity, a multiple regression model is used as follows:

\[ Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 D + u \]

Where -

- \( Y \) = Productivity per acre of paddy crop (Dependent variable)
- \( a \) = constant.
- \( b_1 - b_5 \) = Elasticity of variables.
- \( X_1 \) = Size of holdings in acres.
- \( X_2 \) = The percentage of net sown area irrigated.
- \( X_3 \) = The percentage of net sown area under HYVs.
- \( X_4 \) = The consumption of fertilizers per acre (in Kg).
- \( D \) = Dummy variable (Tractor)
- \( u \) = Random variable, which is included in the model to explain residual effect of other factors on productivity.
EMPLOYMENT MODEL:

We have again used multiple regression model to findout the impact of various explanatory variables on human labour (as a whole), tied human labour and casual human labour employment respectively.

To findout the impact of various explanatory variables on human labour employment as a whole, we have used the following regression model.

(1) \[ Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 D + u \]

Where -

- \( Y \) = Human labour employment per acre in paddy cropp (Dependent variable).
- \( a \) = constant
- \( b_1, b_5 \) = Elasticity of variables
- \( X_1 \) = Size of holding in acres
- \( X_2 \) = The percentage of net sown area irrigated.
- \( X_3 \) = The percentage of net sown area under HYVs.
- \( D \) = Dummy variable (Tractor)
- \( u \) = Random variable.

The same explanatory variables are also used in the following regression models to findout their impact on tied labour and casual labour employment separately.

(2) \[ Y_1 = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 D + u \]

Where -

- \( Y_1 \) = Tied labour per acre (Dependent variable)

* Tied labour is the total of family labour & permanent labour.
To find out the coefficient of correlation among the dependent and various explanatory variables, Karl Pearson's co-efficient of correlation is computed using the following formula:

\[ r = \frac{\xi_{dx \cdot dy} - \xi_{dx} \cdot \xi_{dy}}{\sqrt{\left[ \xi_{d^2x} - (\xi_{dx})^2 \right] \left[ \xi_{d^2y} - (\xi_{dy})^2 \right]}} \]

Where -

- \( r \) = Coefficient of Correlation.
- \( \xi_{dx \cdot dy} \) = Total product of deviation of \( X \) from assumed mean and deviation of \( Y \) from assumed mean.
- \( \xi_{dx} \) = Total deviation of \( X \) series from assumed mean.
- \( \xi_{dy} \) = Total deviation of \( Y \) series from assumed mean.
- \( \xi_{d^2x} \) = Total of Square deviations of \( X \) series from assumed mean.
- \( \xi_{d^2y} \) = Total of Square deviations of \( Y \) series from assumed mean.
- \( N \) = Number of items.

To know the impact of various explanatory variables on productivity and human labour employment, regression coefficients are computed and for their reliability, standard error of each co-efficient is also calculated. Computed \( R^2 \) tells us the joint effect of all variables included in the model on \( Y \) dependent variables (productivity and employment).