CHAPTER VIII
The available empirical studies on Indian agriculture focus on inputs use, yield level and related issues like income and employment. However, most studies have confined themselves to the analysis of the relative efficiency of inputs in high agriculturally developed regions. This makes it difficult to assess the influence of a particular input on another input use, agricultural productivity and production in relation to different agro-climatic regions.

As it has already been observed in the section on review of literature (Chapter II), macro level analysis alone does not provide the base for policy formulation. Secondly, very few studies have highlighted the implications of the combined effects of different input use on agricultural productivity and production in Indian agriculture. For instance, though different types of farm power like labour, animal and machinery can perform similar kind of operations, most of the studies analyse these sources separately.
Further, the available studies on farm mechanisation are also divided in their arguments. While one school of thought argue that as mechanisation increases the output and employment also increase, another school argue that mechanisation reduces output and employment. At the same time, a set of research findings contend that it is very difficult to assess the impact of farm mechanisation as the output and employment levels are also conditioned by various complex socio-economic and agro-environmental factors.

Some of the studies pertaining to the broad spectrum of the farm power use have been reviewed. Based on it, a few issues have been identified for the present analysis. As it has been noted in first and second chapters, due to methodological problems and area covered it was not possible from the existing studies to establish a firm relationship on the inputs used with particular reference to farm power use in agriculture. Therefore, it is in this context that, the present analysis tries to examine the combined effect of all types of farm power sources at a micro level on other inputs use, yield level and related issues in agriculture.

To understand the changing patterns of farm power in terms of growth, availability, use and the economic aspects involved, Tamil Nadu was selected. For a micro level analysis, two districts - Thanjavur and
Coimbatore - were selected from this state. These two districts have different agricultural scenarios in terms of access to irrigation, cropping pattern, soil condition, rainfall and the distribution of farm power stock. Therefore, it was felt that selection of these districts would be appropriate for analysing the issues involving farm power at farm level.

Both macro and micro level analysis has been carried out to examine the growth and availability of farm power stock. Aggregate and disaggregate analyses have been done for the availability, utilisation and the relative importance of the use of farm power across crops, size of land holdings, type of crops, intensity of farm power and level of mechanisation. In addition, the impact of farm machineries on output and employment has also been examined.

Of the different sources of farm power stock available in Tamil Nadu during 1989, machine power alone contributed about 80 per cent of the total farm power stock and the animate (human and animal) power accounted for the remaining 20 per cent. The disaggregate analysis shows that of the animate power labour power contributed about 8 per cent, animal power 12 per cent. Of the machine power, pumpsets accounted for a major share - 75 per cent followed by tractors and tillers - 4 per cent and other machineries 1 per cent. At the macro level, the availability of hp equivalent farm power
stock per hectare for Tamil Nadu is estimated to be 1.69. This is twice the figure (0.86 hp equivalent units) recommended by the NCA for carrying out farm operations on one hectare of land.

Macro level exercise for the growth of farm power stock shows that it is increasing over a period of time. The mechanical farm power stock is increasing at a much faster rate and biological farm power stock is declining marginally. Type-wise growth of farm power stock indicates that human labour stock (in numbers) and labour power (in hp equivalent units) are increasing marginally. On the other hand, both number and power are declining in the case of draught animals.

Among the different machine power sources pumpsets are increasing steadily. Tillers and tractors together are also showing an increasing trend. Other machineries such as threshers, sprayers, crushers etc., are also on the increase. But of them the magnitude of increase of tillers and tractors is phenomenal. However, apparently the magnitude of increase in the machine power has not displaced the biological power.

An analysis of the variation in the growth of different types farm power indicate that it is influenced by many socio-economic and institutional factors such as attitudinal changes, farmers' ability to invest on farm power stock, access to credit, changes
in cropping pattern, increase in the irrigated area, increase in the agricultural production and changes in the stock of an alternative farm power source and government policies. Since various socio-economic, agro-environmental and inter-related issues are involved it is difficult to arrive at any firm conclusion.

After having analysed the macro picture of the availability and growth of farm power stock, the quantum of farm power available in the selected farms and their general agricultural characteristics are examined. Generally, agricultural characteristics of sample farms varied between the two selected districts - Thanjavur and Coimbatore. Further, agricultural characteristics like cropping intensity, irrigation intensity, cropping pattern, source of irrigation, adoption of HYV and local crops and the availability of farm power stock of the sample farm house holds also differ, not only between districts but across land size classes in each district.

In the sample farms, different types of farm power sources like human labour, draught animals and machineries are available. Human labour includes male, female (family) and attached male labourers. Of the draught animals, mainly bullocks are found in the sample region. Machineries such as tractors, tillers, pumpsets (oil engines and electric motors - mostly electric) and sprayers (both hand and oil operated) are also owned by farmers.
The availability of per hectare hp equivalent farm power is found to be more in Coimbatore. Type-wise farm power availability indicates that the draught animal power is more in Thanjavur. Availability of per hectare hp equivalent farm power across size classes reveals that the marginal, small and medium farmers in Coimbatore have more, while in Thanjavur it is the large and very large farmers who possess more farm power.

Availability of farm power stock is found to be closely associated with average land holding size, cropping intensity and irrigation intensity. However, the availability of an alternative source of farm power also influences the relationship. Though a firm relationship could not be established, the availability of farm power stock and agro-environmental factors are found to be responsible for such variations across land size classes and between districts. Also factors like demand for farm power sources (on custom hiring), availability of feed and fodder and cropping pattern also seem to influence the possession of farm power stock. However, the magnitude of the influence differed from district to district and even between size of holdings. Following this, the extent of the utilisation of farm power at disaggregated analysis has been carried out to understand the differences on the magnitude of farm power use (Chapter-VI) and the methodology adopted for this is explained below.
The utilization patterns of farm power has been examined in terms of hp hours. Actual hours used by particular source of farm power has been converted into hp hours. The actual hours of each type of farm power use from both owned and hired sources have also been converted into hp hours. Thus, the extent of farm power use includes owned and hired sources. Per hectare farm power use has been analysed across land size classes, dry and wet land, variety of crops, type of crops, seasons, operations and sources. Also operation-wise analysis of farm power use for selected crops has been carried out. A brief summary of the findings is presented here.

Percentage distribution of aggregate farm power use across land holding sizes reveal that it is more (very high) on very large holdings and less on marginal holdings. The percentage of type-wise farm power use also increases as the size of land holding increases. However, the percentage of animate power (both labour and animal) use is more as compared to machine power on lower strata of land holdings. On the contrary, the percentage of animate power is relatively less than the machine power on upper strata of land holdings. In other words, the share of animate power to total farm power use is more than the machine power on marginal holdings. It is vice-versa in the case of larger holdings. This explains the fact that the
marginal and small holders depend (for use) more animate power and large and very large farmers depend more on machine power.

Another notable feature is that the aggregate use of farm power (in hp units) varies across land holding sizes and districts. District-wise aggregate farm power use indicates that Coimbatore farmers use more farm power than the Thanjavur farmers. The per hectare farm power use is consistently increasing as the land holding size increases in both the districts. Type-wise farm power use shows a direct relationship with farm size indicating large farmers mechanise farm operations. The animal power use reveals an inverse relationship with land holdings. The pattern of labour power use shows mixed trend in both the districts. It may be due to the average holding size and the large farmers' ability to invest more on capital intensive farm power sources such as machineries. Even for getting the machineries on hire basis, lower strata of farmers like marginal and small farmers need to pay rent in lumpsum. As a result, these farmers have to depend mainly on animate power source.

Utilisation of different types of farm power between wet and dry farming indicates that machine power use is more for unirrigated land in Thanjavur than in Coimbatore. The differences in the use of farm power between wet and dry land have been attributed to factors
like adoption of different cropping pattern and mode of operations. District-wise analysis clearly indicates that in both wet and dry regions utilisation of farm power is more in Coimbatore.

The level of farm power use across variety of crops varies. In general, HYV crops require more farm power than other varieties like local and mixed crops. Both the sample districts show similar pattern with little variation for total farm power use. Utilisation of different types of farm power also shows the same trend. The intensity of farm power use is more in Coimbatore and less in Thanjavur for all types of farm power sources for different variety of crops.

Broadly, the crop-wise utilisation of farm power reveal some features. Commercial crops and vegetables require more farm power; millets and other crops require less farm power. However, cereals require moderate farm power (quantum) in both the districts. District-wise analysis for all crops cultivated in both the districts shows that Coimbatore farmers use more farm power than those of Thanjavur. This explains the fact that for some crops farmers manage to complete the operations with one or two sources of farm power. In other words, some farmers complete farm operations with biological power or mechanical power with human labour. The non availability of all sources of farm power (stock), mode of operation, wage rate and other
agro-climatic conditions found to be related to the differences in the pattern of farm power use.

The section on season-wise farm power use shows that in Thanjavur, sample farmers use more farm power in kharif season and less in rabi season. On the other hand, Coimbatore farmers use more farm power in rabi season and less in summer season. However, in both the districts the farm power is used extensively for annual crops like sugarcane.

The season-wise farm power use indicates some variations across seasons. For some seasons farmers use a particular type of farm power on large scale while for other seasons it is less. The time available between season, occurrence of monsoon, rainfall, selection of crop for a particular season, and the farmers ability to get a particular source of farm power are some of the factors that are responsible for such variations.

Operation-wise utilisation of farm power for different land holding sizes has also been examined to assess the differences in the farm power use. The farm power use is analysed for nine operations and it shows that irrigation alone requires a major portion of farm power in both the districts. Other operations like harvesting, ploughing, sowing and threshing also require more farm power. Less farm power is used for operations like manuring, plant protection and miscellaneous.
Operation-wise utilisation of different types of farm power (human, animal and machineries) between sample districts also varies. This is mainly due to the soil type, availability of irrigation, weed growth, distance between threshing floor and plots and mode of operation.

An analysis on the use of operation-wise farm power for selected crops was carried out to examine the differences in farm power use. It was noticed that each crop requires varying quantum of farm power for different farm operations. The magnitude of the differences was attributed to factors like the mode of operation for a particular crop, season on which the crops were cultivated, soil type and the use of other inputs.

Source-wise farm power use has also been examined. Here source-wise farm power use refers to the sources of getting/using farm power like owned and hired. Analysis of source-wise farm power indicates that at aggregate level, more than 75 per cent of the farm power is utilised from owned sources in Thanjavur. This figure is little more for Coimbatore. Type-wise and source-wise analysis of the use of farm power indicates that less human power is taken from owned source in both the districts. More labour power has been taken from hired sources. Contrast to this, sample farmers use more machine power from their own source and very less machine power is hired. But the magnitude of
owned and hired sources varies between sample farms. This is perhaps due to the availability of ready-made farm power stock at farmers' disposal, timeliness of operation, participation of owned human labour for supervision of farming, and other business. Complementary and supplementary effect of machine power with other types of farm power, availability of hired sources etc., are also responsible for such differences.

A regression model was carried out for determining the factors that condition the use of farm power. Land holding size, cropping intensity and total farm power availability (stock) were related with the total farm power used. The regression results have shown that availability of farm power is statistically significant in influencing the total farm power used in the sample regions. Also land holding size and cropping intensity have indicated a direct relationship with farm power used in both Thanjavur and Coimbatore districts. Following this, an attempt has been made to examine the economic aspects of farm power use like the cost structure of inputs and net returns (Chapter VII).

The economic aspects of farm power use in agriculture has been studied to understand the relationship between the farm power use and the yield. The extent of farm power use has been worked out to analyse the economic implications of input use and yield level.
At the first stage, the physical units of selected input use has been examined and the value of different inputs in relation to the extent of farm power use has also been analysed. For some inputs the cost has been imputed and for certain inputs like fertilizers and pesticides the expenditure has been treated as paid out costs. Similarly, value of both main and by-products of output has been imputed. The input-output analysis for different intensities of farm power has been analysed for per hectare of land.

Of the selected inputs like farm power, fertilizer and manure, farm power is extensively used followed by fertilizer and manure. The same pattern has been witnessed on all size classes across different intensities of farm power use. Interestingly, the magnitude of different input use for per hectare of land is higher in Thanjavur than in Coimbatore.

The value of per hectare gross expenditure for various inputs reveals that in both the districts farmers incurred higher proportion of cost on farm power followed by other inputs. The percentage contribution of other inputs for total cost varied between sample districts. In Thanjavur, next to farm power, sample farmers spent more on fertilizer followed by seed, maintenance of machineries, pesticide, land revenue and irrigation. On the other hand, in Coimbatore leaving
farm power cost, proportion of expenditure incurred for seed is more followed by fertilizer, paid out cost, pesticide, manure, irrigation and land revenue. Slight variations in the quantum of selected input use across intensity level of farm power use has also been noticed. Use of selected inputs and the level of farm power have positive relations in both the districts. This clearly reveals the fact that as the intensity of the utilisation of a particular input (in this case farm power) increases, the utilisation of other inputs also increases. In both the districts the value of various inputs use increases as the intensity level increases.

The gross expenditure incurred for various inputs has been examined across land size classes with different intensity of farm power use. In both the districts the per hectare gross expenditure increases with the intensity of farm power use and land size classes.

The per hectare total input cost, value of output and net returns analysis at aggregate level comprising all crops, seasons and variety of crops has been worked out. This analysis shows mixed pattern unlike on the analysis of selected physical inputs use. In other words, the cost structure and value of net returns do not show either direct or inverse relationship with farm size and intensities of farm power use. The variation has been noticed more in
Thanjavur and less in Coimbatore. However, per hectare returns are more for Coimbatore farmers. Thus, despite Thanjavur farmers spending more on inputs, the net returns are less for this district as compared with Coimbatore. This is mainly due to the accessibility to technical know-how, timely application of crucial inputs such as fertilizer and pesticide and proper weeding. Added to these, adoption of valuable crops and increase in yield also responsible for this pattern.

Crop-wise per hectare input cost, value of output and net returns analysis has also been carried out for selected crops. Six crops such as blackgram, greengram, groundnut, paddy, sugarcane and sorghum have been selected for crop-wise analysis. Here this analysis is done for different intensities of farm power use but not by land size classes.

An analysis of total per hectare inputs cost, output value and net returns for black-gram indicates that net returns are high on higher intensity of farm power use farms and less on low farm power intensity farms. As it is expected, both value of inputs, output and net returns show direct relationship with the intensity of farm power use.

Unlike for black-gram, the relationship between net returns and intensity of farm power use is inverse for green-gram. Similarly, the value of output also shows an inverse relationship. However, regarding
the input cost it shows an increasing trend with farm power use.

Groundnut is cultivated in both the districts. The per hectare net returns for this crop shows a direct relationship in Thanjavur and mixed trend in Coimbatore both in terms of input use and output obtained. In Coimbatore value of inputs, output and net returns increase with the intensity of farm power use and decline later.

Intensity level of farm power use for paddy crop is more in Thanjavur and less in Coimbatore. Whatever be the level intensity, the trend is mixed in both the districts. Value of output, inputs and net returns do not show any clear trend across intensity of farm power use. The vast differences in net return can be attributed with variety of paddy crops selected, efficient utilisation of inputs and yield level.

Sorghum is cultivated only in Coimbatore for fodder. For this crop value of output shows a direct relationship with intensity of farm power use. However, inputs cost and net return do not show any clear trend.

Though sugarcane is cultivated on limited scale, the farm power use is extremely high and hence the input-output analysis has been carried out for this crop. Since very few farmers cultivated this, it has been decided to analyse for sample districts and not
across intensities of farm power use. The per hectare input cost is found to be more in Thanjavur and less in Coimbatore. But the per hectare net returns are more in Coimbatore and less in Thanjavur. Access to research institutes and effective land management practices are some of the factors found to be responsible in variations in yield, costs and net returns.

The last section on impact of farm mechanisation on inputs use, yield level and net returns reveals some notable findings. For this analysis the farmers are grouped into five categories. At the first stage, the impact of mechanisation of animate power has been examined. In both the districts, barring a few groups, the animal power use is declining as the intensity of mechanisation increases. Regarding labour power mixed trend is noticed. However, non-machine power using farms employed less human power than the more machine power using farms. It explains the fact that though machineries displace labour power, for some operations it absorbs the human labour.

The aggregate impact of mechanisation on yield level shows some mixed trend. However, it reveals the fact that the net returns increase at a faster rate for low machine power use farms and then it shows a slow rate of increase. This trend has been noticed across farm sizes and in both the districts. Thus, from the
impact analysis it is evident that the level of mechanisation positively influences the output.

The regression model used for identification of the determinants influencing the yield revealed that farm power used and area under paddy significantly influenced the yield (output value). Variables like land holding and fertilizer used also positively influenced the output. Similarly, of the type-wise farm power used, labour power and machine power positively (also significantly) influence the output. However, the draught animal power used inversely related with output.

Based on the above summary of findings it can be summed up that the availability of farm power stock on the selected house holds is found to be more than the requirement. However, some farmers, particularly from the lower strata of the holding size, do not possess farm power stock due to resource constraint. If the improved implements are made available to them it would help to complete the farm practices as the availability of with labour power is more.

Based on the analysis carried out on the use of farm power some inferences can be made. The large farmers who are having more farm power stock and ability to mobilise resources, including hired sources of farm power use relatively more farm power in farming. However, this can be attributed to the allocation of area for different crops and seasons which influence the
use of farm power. The present analysis showed that small and marginal farmers do not use farm power even in proportion to their land under cultivation. As it was pointed out, efforts to supply improved implements would help these sections of the farmers in completing the farm activities.

The source-wise analysis of farm power use indicated that large farmers mainly depend on machine power (owned) and small farmers rely on biological power. This indicates the fact that even after continuous efforts to improve the small farmers, their access to resources, in this case farm power, is found to be difficult. Therefore, efforts should not only emphasize on producing more farm power stock, but also see that it is accessible to all sections of the farming society.

As the use of farm power is operation and crop specific, selection of crops should be based on the accessibility to appropriate farm power stock in a given region.

The economic analysis of the farm power use indicated that the intensity of farm power use led to increase in other input use and yield, however, after certain stage of increase in the intensity level, the net returns found declined. But it is very difficult to relate the above pattern with the issue of farm power alone. Because at aggregate level it is very difficult
to isolate the factor(s) responsible for the increase/decrease in net return as the yield level is conditioned by many factors.

Here, among the sample districts, Thanjavur farmers get relatively less returns as compared to farmers in Coimbatore. This indicates the fact that Thanjavur farmers ineffectively utilise the resources including the farm power. But it is difficult to relate this with resource use for establishing any firm relationship. Because, in general the agriculture is conditioned by among others, climatic factors, pests and diseases, soil type, timely application of crucial inputs and cropping pattern. The accessibility to technical know-how, farmers' adaptability to new developments in agriculture and market forces also play an important role in determining the differences in yield and net returns.

However, crop-wise cost structure, input use, yield and net returns show that Coimbatore farmers fared better than the Thanjavur farmers. As it has already been discussed access to factor (inputs) and product markets are responsible for this. Therefore, efforts should be made to make the resources more accessible to all regions. This would additionally help in reducing the regional imbalances in agricultural development.

Another issue is the mode of irrigation used.
Thanjavur farmers apply flood irrigation as the river is the source available. In Coimbatore well is the main source and the selected farmers found effectively utilised the available water to get more yield. As it was observed the flood irrigation technique would have resulted in reducing the yield in Thanjavur. Therefore, farmers should be made aware of the problems like weed growth caused by the flood irrigation. It would not only increase the yield level but also help in the use of crucial inputs like water in a sustainable manner.

From the foregoing discussions some inferences can be drawn. Regarding the availability of farm power stock at macro level (state level), it is more than the required for completing farm operations. The excess availability is perhaps due to the faster growth of heavy farm power sources like machineries.

As it was noted in the Chapter (IV) on growth of farm power stock, capital intensive heavy machineries are growing at a faster rate. On the other hand, labour intensive sources like labour and animal power (stock) are either marginally increasing or declining. Here the implication would be that in a labour abundant agricultural economy like India the above scenario is undesirable. It is true that the quantum of farm power stock has to be increased to 0.86 hp equivalent for one hectare of land. By keeping the necessity and implications in view, selected farm power sources have
to be encouraged. It is a well known fact that India is possessing a large quantum of draught animal stock and the efficiency is far than the potential. Moreover, human labourers engaged in farming are also on the increase though marginally. Therefore, it is essential to maintain the balance between capital intensive and labour intensive farm power sources.

In addition to these, the locally available implements can be improved for effective use of animal power. The local artisans should be given adequate training and capital to manufacture suitable implements and this would not only increase the efficiency but also attract the farmers who prefer capital intensive farm power sources. Added to this, even the improved implements made by agricultural institutes are not known to the users. Effective demonstration and propagation on the improved implements would help the farmers to adopt them.

Available farm power stock has to be used to the maximum extent. Increase in the area under irrigation and adoption of short duration HYV crops would result in increasing the demand for farm power use.

Another important point here is that the 100 per cent subsidy for power to pumpset users (electric motors) provided by the government needs some modifications for effective use of both electricity and
ground water. The charges can be levied according to the electricity (units) consumed but at concessional rates. This would force the farmers to rationally utilise the electricity and water bailed out through pumps.