Chapter - II

Concepts and Review of Related Literature
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CONCEPTS AND REVIEW OF RELATED LITERATURE

Based on the nature and source of arguments the literature on the subject of mechanisation can be divided into two broad groups. The first group deals with policy issues related to mechanisation. Essentially, this literature is based on expert’s opinions and knowledge and is tied to the policy questions raised by the increased use of tractors. It may be safely argued that this literature is not based strictly on empirical analysis of this phenomenon. The second group of literature consists of more specific empirical analysis of the effects on the tractor use. A major portion of the review presented here concentrates on the second group of literature.

The most common arguments related to this group centre on the cause of mechanisation, its impact on labour use and the associated consequences, and the environment into which mechanisation is introduced. Experts argue that many governments have encouraged tractor use by low import duties, subsidised credit and by maintaining a favourable price for tractors. A different opinion is expressed by Rao\textsuperscript{14} who argues that within the Indian context, institutional credit has not been a major factor in the growth of tractor use. Rather, a rise in the price of agricultural commodities led to increase in wages

and the cost of bullock labour. These made traditional labour sources more
costly than mechanical sources and thus led to increased investment in tractors.

A most powerful argument against mechanisation is put forward by
Griffin, who contends that factor endowments in most underdeveloped
countries are not favourable for farm mechanisation. According to him “Given
the factor endowments of most underdeveloped countries, it is doubtful that
mechanisation with tractors and combines is wise. The machines use a scarce
factor of production (capital) to economise on an abundant factor of production
(labour) and thereby fail to use resources in the most efficient combinations.15
He also argued that mechanisation by its very nature displaces labour. Since
other sectors cannot absorb this labour, the wages of agricultural labour fall.
Labour costs of production as a result of mechanisation would reduce the
income of small farmers through lower grain prices. This would lead to greater
inequalities in income, which might in turn encourage concentration of land
ownership.

The Food and Agricultural Organisation of the United Nations (FAO)
recognises that for machines to do a particular job some degree of labour
saving is implied.16 Mechanisation is essential for land clearance to bring new
land into cultivation. This itself creates a permanent increase in employment

Research Institute of Social Development, Geneva.

16 United Nations, Food and Agricultural Organisation, Provisional Indicative World Plan for
opportunities. The FAO advocates selective mechanisation to remove labour bottlenecks at peak periods in order to permit the intensive use of land and labour or double or triple cropping. The FAO claims that the labour thus saved could be switched to more labour-intensive and cash earning enterprises such as milk production, poultry and livestock.

As stated earlier the second type of literature is based on empirical analysis. The empirical studies vary with respect to focus, methodology and conclusions drawn. The most important issues analysed were the effect of mechanisation on employment, cropping intensity, yield of individual crop and value of agricultural production per acre.

In this chapter a review of the concepts used in the previous studies, various tools employed were presented under the following titles.

Mechanisation

Tractor farms

Non-tractor farms

Human labour

Bullock Power

Cost concepts

Value of crop output

Mechanisation Vs. farm size

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Mechanisation Vs. Cropping intensity
Mechanisation Vs. employment
Tractor use
Review of analytical techniques

2.1 MECHANISATION

Singh et.al. (1971) defined mechanisation as the use of machines like tractors, water pumps, threshers and chaff cutters operated by battery or electricity in the place of similar implements operated manually or by bullock power.\(^{18}\)

According to Sharma and Khalon (1972) complete mechanisation was one where animal was totally replaced by machine power.\(^{19}\)

Ramachandran (1979) defined farm mechanisation as that art of equipping agriculture with mechanical aids for increasing efficiency in the enterprises. An important indigenous plough or switching to mechanical device, like pumps for irrigation, use of tractors, threshers were treated as developments of farm mechanisation.\(^{20}\)

Mechanisation of agriculture was defined as replacement of animal and human power by machinery wherever possible in agriculture involving greater...

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\(^{18}\) K.B. Singh, B.B.P.S. Goel and V.V.R. Murthy, Estimation of bullock power in certain tracts of India, Agricultural Situation in India, 25, p.483.

\(^{19}\) A.C. Sharma and Kahlon, “Impact of Technological Developments on Normative Shifts in Cropping pattern.” Indian Journal of Agricultural Economics, 27, p.158.

investment of capital. It means introduction of tractors, drills, harvestors, threshers, crushers, oil engines and electric pumps in the place of wooden plough, bullock, sickle and country carts.\textsuperscript{21}

Bina Aggarwal (1983) defined mechanisation as essentially a mixed package. Different crops and farm operations tend themselves to different mechanisation alternatives and in so far as farms differ in their cropping pattern and in the extent to which particular techniques as used for a given crop, this is likely to have varying implications.\textsuperscript{22}

Binaswanger (1984) define mechanisation as to included all replacement of human muscle power by machines and implements.\textsuperscript{23}

Anazodo (1986) defined agricultural mechanisation as the process of development and introduction of mechanical assistance of all farms and at any level of sophistication in agricultural production in order to reduce human drudgery, improve timeliness and efficiency of various farm operations to bring more land under cultivation, preserve quality of agricultural products, provide better rural living conditions and markedly advance the economic growth of rural sector.\textsuperscript{24}

\textsuperscript{21} S. Sankaran, Agricultural Economy of India (Madras: Progressive Corporation Private Limited, 1979, p.168.
\textsuperscript{22} Bina Aggarwal, Mechanisation in Indian Agriculture – An Analytic Study based on the Punjab Farms. New Delhi: Allied Publishers Private Limited, 1983, p.2
Tamil Nadu State Planning Commission described farm mechanisation as the process of increasing farm productivity by investing on efficient tools and equipments.  

2.2 DEFINITION OF MECHANISATION

National council of Applied Economic Research (1964) preferred the term ‘Motorization’ to Mechanization. Motorization according to it, would mean substitution of tractors for animals as means of traction as against the mechanisation meaning substitution of machines for any kind of labour animal as well as human.

According to the National Council of Applied Economic Research (1964) Mechanisation meant substitution of machines for any kind of labour, animal as well as human.

According to Singh et al(1971) mechanisation of agriculture means the use of machines like tractors, water pumps, threshers, chaff operated by oil,

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battery or electricity in the place of similar implements operated manually or by bullock power.\footnote{K.B.Singh, B.B.P.S.Goel and V.V.R.Murthy, “Estimation of availability of bullock power in certain tracts of India”. Agricultural situation in India, 25(7) : 483-487, 1971.}

**Patel and Patel (1972)** viewed that any use of mechanized power in the place of human or animal power for agricultural operation amounts to farm mechanisation.\footnote{S.M.Patel and K.V. Patel, “Progress of Farm Mechanisation in India Seminar series IX, problems of Farm Mechanization, India society of Agricultural Economics, p.29-44, 1972.}

According to **Venkattappa (1972)**, mechanization is a picture of sophisticated machines increasingly engaged in the replacement of reduction of human and animal power.\footnote{Venkatappa, B., “Farm mechanisation in India”, seminars series IX, problems of Farm Mechanisation, Indian Society of Agricultural Economics, page 1-15, 1972.}

**Mosher (1974)** pointed out that By farm mechanization we mean introducing the use of mechanical procedures into farm operation in an area where these procedures have not previously been used. In the process both the machines themselves and the institutional arrangements by which they are made available to and used by farmers are included. Strictly speaking, the design and manufacture of farm equipment is external to farm mechanisation as such, but the suitability of equipment for profitable use on farms in specific
localities is so important to the success of farm mechanisation that design and manufacture can usefully be included as part of farm mechanization itself.\textsuperscript{31}

\textbf{Mittal and Singh (1975)} defined mechanised farms as those farms where farm operations such as ploughing, harrowing and threshing were done by tractors.\textsuperscript{32}

\textbf{Stout and Downing (1976)} defined mechanisation to encompass the use of hand tools and animal drawn implements as well as motorized equipments to reduce human efforts to perform certain operation that cannot be accompanied by other means and to improve the quality of work.\textsuperscript{33}

\textbf{Parameshwara Rao (1982)} stated that farm mechanisation means application of mechanical power to perform agricultural operations and to increase farm production and to raise the standard of living of the people working in agriculture. Mechanisation is partial when only a part of the farm work is done by machine. It is complete when animal or human labour is completely displaced by the power operated machines.\textsuperscript{34}


\textsuperscript{32} Mittal F.P. and singh T.F., “Mathematical models for the cost analysis of tractor custom unit”. Indian Journal of agricultural economics 30(1) page – 69, 1975.


2.3 NEED FOR MECHANIZATION

Bainer (1970) observed that machines were more efficient in keeping of the timeliness of the field operations and decreasing the use of human and animal energy.  

Parnape (1970) indicated that mechanization will increase the production and ultimately raise the standard of living and increase economic welfare. He was of the opinion that mechanisation would increase the real purchasing power of the people and thus have a leverage effect in demand for other products.

Tamil Nadu State Planning Commission (1972) described farm mechanisation as the process of increasing farm productivity by investing on efficient tools and equipments.

Moans (1973) explained that agriculture is characterised by small holdings, low farm income and low labour cost. Mechanisation will be successful only through the development of appropriate machines to meet the needs of the conditions prevailing in the country.

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Dandekar and Rath (1976) viewed employment from the perspective of income in that an adequate level of employment must be defined in terms of its capacity to provide a minimum living to population.\(^{39}\)

Smith (1976) defined employment as a state in which a person combined his / her physical and or mental efforts with other resources including other human effort in a production process.\(^{40}\)

Rao (1982) favours mechanization in agriculture and he places some reasons for it.

a. To overcome labour shortage during the peak periods and on draught animals which have low productivity and high costs.

b. To increase the rate at which operations are performed by timely and effective farm operations.

c. To step up total production by using water pumps and adopting multiple cropping.

d. To perform tasks that cannot be done effectively by traditional methods.

e. Many of the major crop operations in India are rigidly bound by the season. Because of the seasonality of agricultural operations, requirement of labour during peak period is very high and hence labour shortage is usually experienced. This necessitates the use of mechanical appliances in our agriculture.


f. As better land preparation and also timeliness of agricultural operations are crucial for higher production, we are forced to use tractors in agriculture despite their adverse effects on employment.

g. Our traditional implements are crude, inefficient and inadequate. It is highly uneconomical to complete agricultural operations using them. They need to be replaced by improved agricultural machinery and implements.41

Rao (1982) argued that a blanket assumption of full employment norm of 48 hours a week implies work of eight hours a day for six days of work which is perhaps not an universally full employment norm to assume as several attached labourers do in fact work more hours that.42

Anazodo (1986) defined agricultural mechanisation as the process of development and introduction of mechanical assistance of all farms and at any level of sophistication in agricultural production in order to reduce human drudgery, improve timeliness and efficiency of various farm operations to bring more land under cultivation, preserve quality of agricultural products, provide better rural living conditions and markedly advance the economic growth of rural sector.43

For the purpose of the present study the level of mechanisation is defined as the art of equipping agriculture with mechanical aids for increasing efficiency in the enterprises. An improvement in the indigenous plough, or switching to mechanical devices like pumps for irrigation, are mechanisation developments as well the use of tractors, power tillers, threshers etc. for agricultural operations.

2.4 TRACTOR FARMS

Shah and Singh (1972) defines tractor farms in Uttar Pradesh as those which had tractors and power threshers.\textsuperscript{44} Shyamal (1974) referred tractor farms as only those which own tractors. Farmers who hire tractors are excluded from this group. Since the number of farms which hire tractors depends on those who own tractors, it was considered important to determine only the conditions that favoured ownership of tractors.\textsuperscript{45}

According to Sharma and Prakash Metha (1972) the tractorised farms were those farms where bullock power has been replaced by tractors.\textsuperscript{46}

Ramachandran (1979) defined tractorisation so as to include the use of motorised mechanical devices such as tractors and power tillers for agricultural operations.\textsuperscript{47}

Joshi et al., (1981) defined tractorisation in terms of ploughing, threshing and pumpsets for irrigation projects. In the present study, tractor farms were considered as those farms which owned tractors to perform various field operations.

2.5 NON-TRACTOR FARMS

Sharma and Prakash Metha (1972) defined non tractorised farms as those where field operations were carried on by bullock power and stationary jobs by diesel engine or electric motor.

Namboodri and Padmanabhan (1976) defined non-tractor farms as those where bullock technology was used for farm operations.

Lal et al (1976) defined non-mechanised farms as those which neither owned tractors nor power tillers but depend on bullocks as a major source of power.

Singh et al., (1975) and Rao (1978) Many authors categorised those farms which were using only bullocks for various agricultural operations as

49 Ibid.
non-tractor farms. At present, farms that never use any power other than the human labour and bullock power constitute non-mechanised farms, even if they used improved implements that are manually operated.

2.6 CLASSIFICATION OF FARMS

Rudra (1971) divided farms into three mechanisation categories: those with neither tractors nor tubewells/pumps; those only with tubewells/pumps but no tractors and those with tractors and which also owned tube wells or pumps in majority cases. Such farms were respectively referred to as non-mechanised, partially mechanised and fully mechanised farms.\(^{54}\)

Tractor farms referred to farms owning a four wheel tractor while bullock farms were, not owning a four wheel tractor.\(^{55}\)

Lal et.al. (1976) referred mechanised farms as those farms which owned tractors and tubewells. They also defined partially mechanised farms as those which own tubewells only as a source of mechanical power.\(^{56}\)

Dorasamy (1979) classified farms into three groups each representing a different level of mechanisation. the three levels of mechanisation considered were (i) farms using bullock for all operations representing purely traditional technology known as unmechanised farms (2) farms using both bullock and


\(^{55}\) V. Ramachandran, Op. Cit., p.34.

hired tractors for farm operations were referred to as intermediate level of mechanisation and (3) farms owning tractors were called highest degree of mechanisation.  

**Tyagi and Pandey (1981)** classified farms on the basis of acquisition of tractor and/or tubewells and threshers as follows: Mechanised farms are those that owned tractors as well as tubewells and threshers and farms which owned tubewell and/or threshers were referred to as partially mechanised farms. Bullock farms were those which do not own any of these three viz., tractor, tubewell and threshers.

In the present study farms were classified into three categories based on the acquisition of machineries that are used for agricultural operations viz., largely mechanised, moderately mechanised and non mechanised farms. Farms that regularly use tractor and tractor based equipments, pumpsets and other equipments that are power operated are called largely mechanised farms. Farms that do not use tractors but use other power operated machines such as pumpsets, sugarcane crushers, power sprayers, groundnut decenticator threshing machines are grouped under the category of moderately mechanised farms. Farms that never use any power other than the human labour and

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bullock power constitute non-mechanised farms, even if they use improved implements that are manually operated.

2.7 HUMAN LABOUR

Shangavi (1969) measured the human labour in mandays with each of eight hours of work by an adult man. All the permanent, family members and hired labour were considered alike and valued at the existing wage rate.\(^{59}\)

Desai and Gopinath (1973) assumed that the ratio of manday of woman day as 1:1 with identical wage rate in most cases for both these categories of workers.\(^{60}\)

Singh and Patel (1973) included all human labour used on the farm for the crop production in the measurement of human labour except those associated with bullock labour. They converted the women and child labour in mandays equivalent on the basis of the prevailing wage rate.\(^{61}\)

Singh (1975) measured human labour in terms of mandays of eight hours. He equated three female labour days to two mandays and three child labour days were equated to one manday.\(^{62}\)

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According to Ramachandran (1979), a day of child labour was treated as half-a-day of adult labour day based on the wage rate differential for adult labour day based on the wage rate differential for adult and child labour. Male and female labour were treated as having identical wage rates. Human labour associated with bullock labour and tractor labour were excluded.63

Sengottuvelu (1982) considered 1.50 women and three juveniles each of eight hours work as one man day unit and this ratio is based on the wage rate prevalent for the various categories of labour.64

In the present study adult labour was measured in terms of mandays of eight hours work and women days were converted to equivalent mandays based on the wages received by the casual labour in the study area. Three women days were taken as two mandays and three juveniles of eight hours of work as one day. Human labour associated with bullock power and tractor were excluded.

2.8 BULLOCK POWER

Singh (1975) defined a bullock team in terms of a pair of bullocks and the person needed to operate the bullocks for an eight hour day.65

The same concept was used by Anbalagan66 (1977) and Kubendran67 (1980).

Bullock power is defined as a pair of bullocks and a person needed to operate the bullocks in agricultural operations for eight hours a day.

They also define farm labour income as what the farmer and his family receive for management, risk and their physical labour that is gross income minus cost B and Net Income (profit or loss) as gross income minus Cost C\(^68\).

For the present study gross income is defined as the total value of the main product and by product of the particular crops valued at the market price. Net income is defined as the gross income less cost of cultivation of crops, live stocks maintenance, maintenance cost of farm buildings and farm machinery and equipments.

2.9 COST

Bradford and Johnson (1964) categories farm expenses into four types:

1. Items which are wholly used within the year. These items include seed, feed, fertilizers etc. This is sometimes called current expenses.

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\(^{67}\) J. Kubendran, Impact of Tractorisation on Income and Employment in Bhuvanagiri Block, South Arcot District, Unpublished (Marketing) Thesis, Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, 1980.

2. Depreciation on properties.

3. Decrease in inventories of operating capital, feed and supplies other than feed.

4. Uses of the labour services performed by the members of the family other than the operator\(^{69}\).

Directorate of Economics and Statistics also categories costs into cost \(A_1\), \(A_2\), \(B\), \(C\). Cost \(A\), approximates the actual expenditure incurred in kind and cash and it includes (a) Hired human labour (b) owned and hired bullock labour (c) seeds, (d) manures and fertilizers, (e) Plant protection chemicals (f) machine labour (g) land revenue, cess, water rates (h) depreciation on implements, machinery and farm buildings (i) interest on working capital.\(^{70}\)

Cost \(A_2\) is cost \(A_1\) plus rental value of leased in land. This applies only for tenancy farms Cost \(B\) is Cost \(A_2\) plus interest on fixed capital excluding land and rental value of owned land. Cost \(C\) is Cost \(B\) plus imputed value of family labour.

**Sharma (1969)** divides the cost of production of farm crops into fixed cost and variable cost. The fixed cost includes cash expenses on permanent human and animal labour, depreciation on farm implements and machineries, land revenue and cesses, rental value of land and interest on permanent investment other than land.


\(^{70}\) Directorate of Economics and Statistics, op cit.
The variable cost covers wages paid to hired human labour, cost of seed manures and fertilizers, irrigation charges betterment levy and miscellaneous costs such as plant protection charges, cost of gunny bags and interest on variable costs.\textsuperscript{71}

**Kahlon (1972)** observed that the index of cropping intensity was 177.62 for the pure tractor farms as compared to 158.65 percent for the pure bullock farms.\textsuperscript{72}

**Bernard and Nix (1973)** have classified cost in farming into fixed cost and variable cost. Fixed cost represents farming expenses on an overhead nature and does not change with the levels of output taxes, depreciation, cash rent, interest payments form the fixed cost. Variable cost refers to the farming expenses which change with output. It relates to the variable resources.\textsuperscript{73}

**Mittal and Sacena (1974)** define fixed costs as those which are independent of the level of production whereas variable cost as those which vary with the level of production.\textsuperscript{74}

**Bina Agarwal (1983)** points out that the use of tractors and tube-wells in comparison with the use of bullocks and canals respectively is associated with higher cropping intensity. However, the advantage of tube-wells over canals is found to be much greater than that of tractors over bullocks.

\textsuperscript{71} A.C. Sharma, “Scale Economics in the production of Farm crops in the cotton Belt of Punjab” Indian Journal of Agricultural Economics 49(3) 283, 1969.

\textsuperscript{72} Kahlon, A.S. Op cit p.55.

\textsuperscript{73} C.S.Bernard and J.S.Nix “Farm Planning and control”. (Cambridge, cambridge University press, 1973) : 45.

\textsuperscript{74} J.P.Mittal and R.P.Saxena “A mathematical Expression for cost analysis of Farm Equipments”. Indian Journal of Agricultural Economics, 29(1) : 51, 1974.
Among the tractor using farms, it is essentially those owning tractors which account for the higher average cropping intensity those depending solely on hired tractors are not found to differ very much from bullock farms in their level of cropping intensity.\textsuperscript{75}

\textbf{2.10 COST CONCEPTS}

Mittal et.al., (1964) divided machinery costs into two categories of fixed and variable costs. Fixed cost referred to the costs which were independent of the level of production. Variable costs were those which varied with the level of production. Fixed costs include depreciation, interest on fixed capital, Shelter maintenance, taxes and insurance. Variable cost includes labour, fuel and lubricating oil, repairs and replacements.\textsuperscript{76}

Umakesan (1971) estimated the total costs and the variable costs for tractor and non-tractor farms. Total costs comprised of all variable costs in the cultivation of crops, maintenance charges of permanent labour and cost of maintenance of cattle not imputed to the cost of cultivation of crops, repairs to building and capital stock, interest on working capital, livestock and capital stock, depreciation of buildings, taxes and insurance and interest for the same. Variable costs in the cultivation of crops comprised of expenses for crops,


imputed cost of farm grown seeds, manures, family labour, permanent labour and owned capital used in the cultivation of crops. Variable costs were computed cropwise and aggregated for all the crops grown in the farm. Depreciation and other fixed costs were computed for the farm as a whole and the total cost was worked out for the entire farms.\(^77\)

Singh and Sirohi (1973) included depreciation, repairs and interests on fixed capital, associated working expenditure in the form of fuel, lubricants and interest charged in calculation of maintenance cost of tractor. Depreciation, interest on fixed investment, cost of feed, values of human labour associated with maintenance of livestock and interest on working capital were included in the maintenance costs of bullocks.\(^78\)

Anbalagan (1977) in calculating the cost of bullock labour per day, included the value of feeds and fodder, both owned and purchased, human labour associated with the maintenance of the animals, cost of ropes, paints and veterinary charges, shoeing charges, interest and depreciation on animal shed. The returns from off-farm earnings and the value of farm yard manure were deducted from the total maintenance cost.\(^79\)

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Maran (1984) in estimating fixed costs on machine power included depreciation, interest on average capital investment, repair and maintenance, taxes and insurance. Variable cost comprised of costs of diesel or gasoline, oil, grease and operator’s wages.\(^{80}\)

National Bank for Agriculture and Rural Development (1987) in its study at Periyar and Thiruvarur Districts of TamilNadu computed the annual operation and maintenance costs of tractor and power tiller by including the cost incurred on diesel, lubricants, repairs and maintenance, driver’s salary, insurance and taxes.\(^{81}\)

In the present study annual fixed cost includes depreciation in tractor and accessories, insurance and taxes, repair and maintenance costs and registration costs. Repair and maintenance costs are usually considered as variable cost, but some durable assets deteriorate with time even though they are not used. So it was included under fixed cost. Variable cost was computed by summing cost of fuels lubricants and wages of the driver.

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\(^{80}\) C.L.Maran, Profitability analysis for a 3 hp and a 6 hp power tiller. Lecturer Handout, Agricultural Engineering Training, International Rice Research Institute, Phillipines, 1984, p.3.

2.11 VALUE OF CROP OUTPUT

Chauhan (1973) defined gross income as the value of retained as well as marketed crop output and also the income from allied activities such as poultry and dairy at the prevailing prices.82

Shyamal (1974) measured crop output in current value terms. It was the gross of all outputs and included by-products.83

Ramachandran (1979) defined gross output per farm in the value of physical output of the primary and secondary produce as quoted by the farm. For farms which did not sell particular produce the same is evaluated at the average price which is obtained by dividing the value of total produce of a particular commodity reported by all farmers by total quantity. The value of the secondary produce reported by the farm was added to the value of the primary produce.84

Mander and Grewal (1988) defined the value of agricultural output in rupees which included the value of crops and their byproducts on the farm. It also included custom rental income from machinery.85

In the present study the Gross farm income per farm is the value of physical output of the primary and secondary produce as quoted by the farm.86

84 V. Ramachandran, Op.Cit., p.144
86 For farms which did not sell a particular produce the produce is evaluated at the average price which is obtained by dividing the value of total produce of a particular commodity reported by all the farmers
It also included the custom rental income from machinery. The farms did not maintain any record of non-agricultural source of income and were not within the scope of present study, hence were excluded. The farms did not maintain any record of the production of livestock products.

2.12 MECHANISATION Vs. FARM SIZE

Desai and Gopinath (1973) found that average size of tractor farms 11.16 ha. was 82 per cent larger than of bullock farms, 6.13 ha. The size of custom hiring farm 5.93 ha. was smaller, though marginally, than that of bullock farms.\(^87\)

National Council of Applied Economic Research (1973) in their studies in nine states of India found that the average size of the tractor operated farm was 13.8 ha. as compared to 8.56 ha. for bullock operated farm. In tractor farms 88 per cent of the area was irrigated whereas in bullock operated farm only 80 per cent of the area was irrigated.\(^88\)

According to Shyamal (1974) the average size of the operational holding of tractor farms was 34.26 acres and 90.06 per cent of their gross cropped area was irrigated.\(^89\)

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A study conducted by Department of Agriculture (1983) in Ludhina District about farm power in Punjab revealed that all the households in tractor-owning class had an operational holding of more than 5 acres.\footnote{Department of Agriculture, “Farm Power in Punjab”, Agricultural Situation in India, 38(2), 1983, p.557.}

Anazod (1986) estimated rice farm size as 2.5 ha. and 13.15 ha. which were operated by animal power and tractor power respectively. Whereas the maize farms size were 13.04 ha. and 6.25 ha. operated by animal and tractor power.\footnote{Department of Agriculture, “Farm Power in Punjab”, Agricultural Situation in India, 38(2), 1983, p.557.}

Taori (1987) stated that in India out of 81.4 million farming households, 44.5 million (54.6 percent) are marginal farms and 14.7 million (18 per cent) are small farmers. In short 73 per cent of farmers own barely 23.5 per cent of total cultivated area. According to NCAER study land holding where tractor ownership and usage pattern have been under.

<table>
<thead>
<tr>
<th>Farm size</th>
<th>Tractor owner (per cent)</th>
<th>Tractor user</th>
<th>Bullock farming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 2 ha</td>
<td>1.3</td>
<td>64.0</td>
<td>34.7</td>
</tr>
<tr>
<td>2 – 4 ha</td>
<td>4.2</td>
<td>79.3</td>
<td>16.5</td>
</tr>
<tr>
<td>4 – 10 ha</td>
<td>15.2</td>
<td>74.5</td>
<td>10.2</td>
</tr>
<tr>
<td>Above 10 ha</td>
<td>41.4</td>
<td>52.0</td>
<td>6.2</td>
</tr>
<tr>
<td>All farms</td>
<td>5.4</td>
<td>68.5</td>
<td>26.1</td>
</tr>
</tbody>
</table>

The small and medium farmers are substantially using tractor on hire though negligible percentage of them are owning tractors. Overall 68.5 per cent
farm households were using tractor on hire. In India we have one tractor per 224 hectares of land against world average of 66 hectares of land.\textsuperscript{92}

**Mander and Grewal (1988)** concluded, the investment on tractor use was economically justified only on farm size of 20 acres and above.\textsuperscript{93}

### 2.13 MECHANISATION Vs. CROPPING INTENSITY

**Acharya (1973)** examined the impact of high yielding varieties and mechanisation on demand for farm labour input, found that tractorisation enabled the farmers to increase the intensity of cropping by 35.5 per cent which had a positive effect on labour employment.\textsuperscript{94}

**Shyamal (1974)** estimated the cropping intensity and the value of output per acre in tractor farms were 195.42 and Rs.1437.37 respectively while the corresponding figures for non-tractor farms were 164.97 and Rs.1194.41 respectively.\textsuperscript{95}

**Lal et.al (1976)** found that sugarcane, wheat and maize showed increased yields on the mechanised farms followed by partially mechanised farms. For mechanised and partially mechanised farms the cropping intensity

\textsuperscript{95} Roy Shyamal, Op.Cit., p.45.
were 177.50 and 162.23 per cent as against 121.41 on the bullock operated farms.96

**Chauhan et.al (1981)** found that the cropping intensity was 198.24 percent on the mechanised farms and 137 percent on the non-mechanised farms. The input ratio was 1:1.75 on the mechanised farms and 1:1.45 on the non mechanised farms97

**Agarwal (1983)** conducted a crop specific analysis of a high yielding variety of wheat in Punjab in 1971-72 and found that the tractor owning farms has a higher level of cropping intensity than tractor hiring farms. Those which depended exclusively on hired tractors had same cropping intensity as the bullock farms.98

**National Bank of Agriculture and Rural Development (1987)** inferred that the proportion of the area under cash crops was relatively larger in both tractor – owing and tractor – hiring farms in comparison with bullock farms. Tractor owned farms obtained a higher average yield for almost all the crops compared to that by tractor hirers and bullock users in Eastern Uttar Pradesh.99

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Khaleel Tatley et.al., (1990) concluded that tractor use has somewhat ambiguous effects on cropping intensity. Tractor owners seem, generally, to have a significant higher cropping intensity that tractor hirers of formers who depend on drought animals. Tractor hirers have higher cropping intensity than farmers using animal powers\textsuperscript{100}.

2.14. INCOME

Malya (1961) defines income as the total agricultural household income of the family consisting of receipts from occupation, dairy enterprise, rent received, interest on loans and remittance received, if an\textsuperscript{101}.

Nandal (1972) defined the term farm income as the value of the crops and live-stock products sale of farm assets, receipts of rent, custom services etc.\textsuperscript{102}

Sharma (1972) defined the gross income as the income from the crops grown, the value of both main products and by products were considered in estimating the gross income.

\textsuperscript{100} Khaleel Tatlay, Derek Byerlee and Zulfigar Ahmad, Role of Tractor and Tubewells and Plant Breeding in Increasing Cropping Intensity in Pakistan’s Punjab. Agricultural Economics, 4, 1990, pp.13-25.


\textsuperscript{102} Nandal D.S. “Investment pattern in Haryana State” Indian Journal of Agricultural Economics 28(5) : p-75 1972.
Farm income is the difference between receipts and expenses. It is what the operator received for his own and family labour for the year and for the use of the capital invested by them.\textsuperscript{103}

Rai et al.,(1972) define income of agricultural house hold, to include the total agricultural income, loan taken and non – agricultural income received during the period under study.\textsuperscript{104}

Pandey et al.,(1972) define income as the total of agricultural and non-agricultural income consisting of those received from commercial establishments, carpet weaving, other trades.\textsuperscript{105}

Kahlon (1972) estimates gross income of farms family by adding all the incomes from farms non-farm sources and borrowings from institutional and anon-institutional sources.\textsuperscript{106}

Directorate of Economics and statistics defines farm business income as the measure of earning of the farmer and his family for management, risk, their labour and capital investment. (Gross receipts minus cost $A_1 / A_2$).

\textsuperscript{103} Sharma, R., “Explanatory Notes on important terms relating to crop loan” Financing Agriculture, 4(1) : p.29, 1972.
2.15 MECHANISATION Vs EMPLOYMENT

Parmer (1970) in his study on the Green Revolution in Punjab indicated that mechanization would prove a boon than a curse if alternative employment could be arranged for the agricultural worker.\textsuperscript{107}

Misra (1972) observed that per hectare decrease in human labour employment varied from 6.67 percent in maize to 57.78 percent in wheat while decrease in bullock labour varied from 64.71 percent in Maize to 90.48 percent in wheat.\textsuperscript{108}

Raj (1972) reported that tractorisation did not result in any significant displacement of wage labour. The installation of pumps and tube-walls created demand for casual labour in replacement of permanent farm workers but the acquisition of tractors created demand for more permanent farm workers but the acquisition of tractors created demand for more permanent farm workers.\textsuperscript{109}

Bhattacharjee (1972) viewed the term productivity as the output per unit of input in farm business.\textsuperscript{110}

Singh and Singh (1973) in their study on the impact of mechanisation on human and bullock labour use in two regions of uttar Pradesh have found


\textsuperscript{108} Misra S.P. “Impact of tractorisation – A study in a Tahsil of M.P.” Indian Journal of Agricultural Economics page 237 31(2) 1972.


that the magnitude of labour displacement due to tractorisation decreased with the increase in farm size.\textsuperscript{111}

Desai and Gopinath (1973) estimated that the employment of human labour per hectare of cotton was highest on tractor farms (194 days) followed by custom farms (176 days) and bullock farms (106 days). Whereas for paddy the employment of human labour per hectare was highest on bullock farms (163 days) than custom farms (152 days) and tractor farms (144 man-days). For tobacco human labour employment per hectare was higher on tractor farms (263 man days) than custom farms (171 man days) and bullock farms (167 man days). Thus human labour employment increased more on tractor farms than on bullock farms for cash crops while for non-cash crops, employment of human labour declined.\textsuperscript{112}

Motilal (1973) estimated that the bullock and tractor farms used 720.14 and 490.92 hours of human labour per hectare respectively. Hired labour employment showed a positive trend with increase in farm size for both bullock and tractor operated farms. Family labour tends to decrease with increase in the farm size for bullock operated farms. Human labour employment fell by 32 percent on the tractor farms as compared to the bullock farms while the use of family labour per hectare decreased by 19 percent. The displacement effect of tractorisation on human labour was 44.3 percent for hired labour.\textsuperscript{113

\textsuperscript{111} Singh L.R. and Singh R.V. Op Cit., p.95.


Misra (1976), while analysing the impact of mechanisation in Madhya Pradesh, found that the employment of human and bullock labour decreased on the tractor operated farms.\textsuperscript{114} The decrease in human labour employment per hectare varied from 64.71 percent in maize to 57.58 percent in wheat while decrease of bullock labour varied from 64.71 percent in maize to 90.48 percent in wheat.

Roy (1978) conducted a study on farm tractorisation productivity and labour employment in order to find out the impact of tractorisation on employment and concluded that the use of tractors have resulted in seven percent more employment and 23 percentage higher output in wheat farms.\textsuperscript{115}

Sharma (1978) while studying the comparative statistics of labour input per hectare on two types of farm organisations concluded that the labour use was slightly higher (1.96\%) in mechanized farms as compared to bullock operated farms.\textsuperscript{116}

Singh (1979) in his study on the economics of tractor use in Punjab has observed that the utilisation of human labour in the case of medium and large sized tractor frames was 18.85 and 33.03 percent less as compared to bullock farms.\textsuperscript{117}


\textsuperscript{117} Bhagat Singh, “Economics of Tractor use” Yojana 23(9) : 19, 1979.
Dorasamy (1979) analysed the operation wise demand and supply of agricultural labour in Chittoor and found that ploughing, planting, maintenance and harvesting formed 7, 20, 34 and 39 percent of the labour use in crop production in unmechanised farms. On intermediate and mechanised farms, however, these operations formed 4, 20, 38 and 38 percent and 1, 23, 37 and 39 of labour use respectively. The maximum labour displacement on mechanised farm was 88 hours per acre, while with intermediate technology, it was 40 hours per acre. Cropping pattern emerged as a major factor influencing labour use in non-ploughing operations. It is found to be an important determinant of intensity of labour use in ploughing operations. He also showed that approximately 900 hours of ploughing labour was displaced in tractor owning farms of 13 acres. On farms hiring tractors nearly 400 hours of ploughing labour was displaced.\textsuperscript{118}

Sharma and Sirohi (1980) showed through functional analysis that one per cent increase in farm mechanisation would lead to 0.05 per cent decrease in labour employment in Alipur block of Delhi.\textsuperscript{119}

Diwakar (1989) showed that the indigenous and modern devices required 45 and 19 man days for irrigating one hectare of barley crop and 195 and 63 man days for one hectare of chillies respectively. For cotton, the labour requirement for irrigation and other operations on electric tubewell was found to be 25 and 186 man days respectively where as it was found to be 197 and

\textsuperscript{118} G. Dorasamy, Op. Cit., pp.136-137.

\textsuperscript{119} Ibid.,
192 man days respectively for charas. Similarly 133 man days were engaged for irrigation of wheat crop on farms with mohite while it was only 19 man days on electric tubewells.\textsuperscript{120}

\textbf{Sidhu and Grewal (1990)} estimated for the stated as whole, tractor – operated farms employed a little more labour of 1114, hours as compared to bullock operated farms where it was 1099 hours. This difference however, was not significant. He also concluded for all zones and the state as whole the proportion of hired labour (permanent + casual) to total labour used was greater than family labour.\textsuperscript{121}

\textbf{Dixit and Bhadwaj (1990)} concluded that human labour employment per acre (75 man days) was higher in bullock farms in comparison to (71 man days) the tractor owned farms in the case of family permanent and casual labour employment were higher in the bullock operated farms while permanent labour was higher on tractor owned farms.\textsuperscript{122}

Manohari. K (2010) The integrated Rural Development Programme, the Poverty eradication and rural development measures have given importance to women agricultural labourers in income generation and asset creation. The TANWA project has taken steps to impart training to the women in agriculture. But much has to be done to the women agricultural labourers in the preventive

\textsuperscript{120} B.W.Sharma and A.S. Sirohi, “Labour Employment Implications of Farm Mechanisation and Multiple Cropping in Alipur in Delhi,” Agricultural Situation in India, 35, 1980, p.544.


\textsuperscript{122} V.K.Dixit and J.L. Bhadwaj, “The Impact mechanisation in farm employment in Raipur District of Madhya Pradesh Agricultural Situation in India, July 1990, p.28.
and curative health aspects. Insurance and old age pension facilities should be 
created exclusively for women agricultural labourers.123

**R. Rajeswari (2010)** Empowerment of Women is therefore the project 
of controlling power and strengthening of their vitality. Of the three broad 
categories of empowerment viz., Economic, Social and Political. The first is 
the key and may lead to other kinds. Efforts of being made through special 
development programmes with greater gender sensitivity.124

**Vidhya. R (2010)** The Tamilnadu government has taken the serious 
steps to improve the women’s development through the mahilir Thittam. It 
makes the women to think independently and helps to enrich their knowledge 
in each and every social upliftment as pandit Jawaharlal Nehru dream.125

**Vidhya. R (2011)** Fabrics, like rugs, made in Erode are famous in India. 
Erode District is an important market centre for Turmeric, a spice commonly 
used in curries. Turmeric is also used as a fabric dye. The turmeric is collected 
from Erode District and from adjoining districts of Tamil Nadu and Karnataka, 
including Mysore. Other specialities include Uthukuli butter and Kangayam 
bulls. Gobichettipalayam is well known for its white silk, plantain and coconut 
production. The country’s first automated silk reeling unit is in 
Gobichettipalayam. Erode is well known for handloom, powerloom textile

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124 R. Rajeswari (2010), Socio-economic status of Women Southern Economist, Volume No.49, No.1, May 1, 2010 P.65
products and readymade garments and hence called the powerloom city of India. Products such as cotton sarees, bed spreads, carpets, lungies, printed fabrics, towels, dhotis are marketed here. In mid-2005, Bhavani Jamakkalam (Bhavani Bedsheets) was registered as a Geographical Indication by the Government of India. Now-days more and more spinning mills which produce yarn for the power loom are setup in and around the town of Erode. Chennimalai is also famous for textiles. Turmeric powder, used extensively in Indian cuisine, finds the Asia’s largest & important market centre in Erode District.126

Vidhya. R (2013) Science with a human face’ is the credo that ICRISAT swears by. At ICRISAT, participatory and interdisciplinary research has evolved towards the development of an integrated genetic and natural resource management (IGNRM) approach. This approach takes advantage of an integrated strategy using core competencies to enhance productivity gains with equitable benefits through genetic enhancement and biotechnology, crop breeding, soil and water management, food safety and social science perspectives.

Given the persistent problems of drought and water scarcity in the drylands, ICRISAT’s research addresses water scarcity on two fronts – by utilising natural resource management principles and techniques to improve moisture content, fertility, soil depth, organic matter, rainwater utilisation

through watersheds and water conservation and by employing plant breeding and biotechnology research to improve water-use efficiency and drought tolerance in crop genotypes.\textsuperscript{127}

\section*{2.16 TRACTOR USE}

\textbf{Motilal (1973)} reported that the annual use of tractors in Delhi was 763 hours a year as against the recommended norm of 1000 hours a year by the tractor manufacturers. The variation was wide, the range being 373 to 1243 hours. Tractor use per year increased with farm size.\textsuperscript{128}

\textbf{Parkale and Kulkarni (1976)} reported that annual tractor use in Maharashtra State was 943 hours of which custom service accounted for 71.65 per cent and own farm use 28.35 per cent custom service was found to increase with increase in horse power.\textsuperscript{129}

\textbf{National Bank for Agriculture and Rural Development (1987)} found that the average annual operational use per tractor was 915 hours and that of power tiller was 766 hours in Tamil Nadu. Out of the total operational use the custom service accounted for 481 hours (52.60 per cent) for tractor and 406 hours (53 per cent) for power tiller. The pattern of operation – wise use of tractors and power tillers indicated that the owners as also the hirers used

\textsuperscript{127} Vidhya, R., ‘Science with a Human Face : A View’, Southern Publishers, Volume 51, Number 18, January 2013, p.5.
\textsuperscript{129} D.G. Parkale and S.D. Kulkarni, Economics of Tractor
tractors mainly in preparatory tillage and transport of agricultural goods and power for completing tillage operations.  

2.17 REVIEW OF ANALYTICAL TECHNIQUES

The analytical techniques reported in the literature for studying the economics of farm mechanisation have varied considerably depending upon the objectives of the study and the adequacy of data base. Some of the important of these analyses will be discussed briefly.

**Timmer (1972)** studied the choice of rice milling facilities in Indonesia. He used the cost-benefit analysis. In the analysis he corrected for distortions in market prices eg. an overvalued currency exchange rate. Most importantly Timmer assumed that the real cost of labour was lower than the market hiring price.  

**Bashir Ahmed (1972)** employed linear programming techniques to analyse the impact of farm mechanisation at the micro level in Pakistan. He selected a representative farm from a small cross-section survey and applied linear programming at different levels of mechanisation to indicate the resultant impact on output, income and employment on farm.  

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131 C.P.Timmer, Choice of Techniques in Indonesia, Discussion Paper 72-74 Food Research Institute, Stanford University 1972.  
Roy and Blase (1972) in their paper aimed to identify the effects of farm tractorisation on output and human labour on farms in Punjab. Cobb-Douglas production functions were fitted to farms owning tractors and farms not owning tractors using ordinary least square criterion. Comparisons were made between the estimated production functions of farms owning tractors and not owning tractors by comparing their estimated co-efficients. The specification of variables in the production function was done with less care by omitting variables. There is no explanation for excluding bullock power. Cropping intensity and purchased inputs and included only fertilizer, irrigation, human labour, operational area and tractor power. In the production function such omissions are likely to introduce specific bias in the OLS estimates of regression coefficients.¹³³

Singh and Day (1972) adopted the recursive linear programming technique in a study of agricultural development in Punjab. The contribution of mechanisation to the development of agriculture was one of the areas of inquiry in their study.

The method of analysis consists of a series of annual linear programme, the constraints on one year’s programme being dependent upon the resultant of

previous year programme. The model simulated the impact of new technology in Punjab for 1952-65 and also made projection to 1980.\textsuperscript{134}

\textbf{Acharya (1973)} conducted a cross sectional survey of farm employing different levels of mechanisation in Punjab. In an attempt to assess the impact of farm mechanisation on productivity and employment he used regression analysis and analysis of variance.\textsuperscript{135}

\textbf{Namboodiri and Padmanaban (1976)} studied farm mechanisation in Anand Taluk. Their major objective studies are (1) Private benefit cost analysis of tractor technology and bullock technology at the existing farming situation (2) The profitability of replacing bullock technology with tractor technology and benefits that accrued from them. They used cost-benefit analysis under the important assumption that one tractor sample equals to two bullock samples in size.\textsuperscript{136}

\textbf{Rebello et al. (1976)}\textsuperscript{137} viewed the bullock power in terms of plough unit. A plough unit includes a pair of bullocks along with a man.

\textsuperscript{134} Inderjeet Singh and Richar Day, Capital Labour Utilisation and substitution in punjab Agriculture “Occasional Paper Number 4 70, Department of Economics and Sociology, Ohio State University, Columbus, Ohio, March 1972.


\textsuperscript{136} N.V. Namboodri and Padmanaban, Op.Cit.

Namboodri and Padmanaban (1976)\textsuperscript{138} defined the term non-tractorized farms as those farms where bullock technology was used for operations.

Rao (1978)\textsuperscript{139} reported that the existence of holdings with fragments distributed in many places rendered tractor farming unprofitable.

Ramachandran (1979) studied on economics farm mechanisation and developed a simultaneous equation system explaining relationship between tractor use and tractor ownership in a general system following the procedure outlined by Heckman (1978). The study also develops estimation procedures to consistent estimates of the parameters of the simultaneous equations system when one or more of the endogeneous variables are limited to dependent variables. He concluded that two stages profit estimates of the model determining the proportion of tractor use by Gujarat Sample farms support the hypothesis that the use of tractors is higher on farms owning tractors than farms not owning tractors.\textsuperscript{140}

Patil (1985) suggested that segregation of the impact of tractorisation and other inputs on productivity of crops is important in the present context of controversy over farm mechanisation in increasing productivity of land. An attempt had been made to separate the effect of tractorisation, manures,


\textsuperscript{140}V. Ramachandran, Op.Cit., p.22.
fertilisers and other capital inputs and human labour on the yields of major crops with the help of decomposition analysis.  

**Mander and Grewal (1988)** collected 180 randomly selected farmers spread over six development blocks located in different agro-climatic region of Punjab during the agricultural year 1985-86, to evaluate the estimates of resource use, the ratio of marginal value of productivities of different capital inputs obtained from the production function analysis to their respective factor costs. These ratios were then statistically tested for their difference from unity by using the t-test.  

**Dixit (1990)** made an attempt to find out the impact of tractorisation on farm employment in Raipur district of Madhya Pradesh. A multiple linear regression analysis was used on a cross-section of farms to explain the variation in human labour employment per acre. They have used a dummy variable to measure the net impact of using tractors instead of bullocks.  

**Sidhu and Grewal (1990)** conducted a survey in three homogeneous zones to study the factors affecting demand for human labour in Punjab agriculture at different levels of technology. These holdings were classified into bullock-operated farms and tractor-operated farms. On the basis of main source of draft power, these farms assuming the level of adoption of seed, irrigation, fertilizer and technology, are directly related to the level of

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mechanisation. The level of production on the farm depends on the labour use on the farm and labour use depends on the level of output. Given the existence of two way relationship a simultaneous equation viz., labour employment equation and output equation was considered to be appropriate.\(^{144}\)

None of the analytical techniques mentioned above is without limitations. Cost-benefit analysis is very useful when the choice is between multiple alternatives. However, frequently confusion prevails, even among economists and among economist and engineers due to lack of understanding financial profitability of mechanisation to an individual or a project and its economic profitability to the society.

Linear programming is the best tool available for deciding the optimum combination of resources use on individual farms. However, the main problem is that the farmers maximise the profit subject to certain constraints. The overriding constraint of risk aversion is not easily incorporated in this method.

Recursive linear programming is an extremely useful approach to analyse firm’s growth over size. However its use for making regional projection is questionable because it treats a region as an aggregate of one of small terms.

Multiple regression analysis and analysis of variance of cross section data are potentially very useful if adequately available. However, the results may be of limited use to policy makers as a result of lack of data and of the bias

\(^{144}\) S.S. Sidhu and Grewal, Op.Cit., p.32
resulting from the omission of relevant variables. For example, there has been a
tendency in the literature to attribute all observed changes in productivity to
mechanisation without duly recognising the contribution of other modern
inputs.

While each one of the analytical techniques mentioned above has its
merit and limitations they have been used rather extensively in research
pertaining to farm mechanisation. As stated above, the choice of the technique
is mostly dictated by the nature and reliability of the data and the specific
objectives of the study.

Aphiphan Pookpakdi (1992) Observe that Green Revolution made a
notable contribution to raising the production of rice and wheat by small-scale
farmers, particularly in Asia and the Pacific. The high-yielding varieties
(HYVs) of rice released in the 1960s increased the productivity of rice by about
70% and of wheat by 150%. The HYVs are responsive to very high
applications of fertilizer, and are efficient producers under intensive
management conditions (RAPA 1989).

One indirect effect of the Green Revolution was to reduce the output of
protein-rich grains and pulses which contributed greatly to ensuring a balanced
diet for the rural poor (FAO 1991b). These crops were no longer competitive
in terms of financial returns per hectare. The Green Revolution has also raised

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145 Aphiphan Pookpakdi (1992) Sustainable Agriculture for Small-Scale Farmers: A Farming
Systems Perspective Department of Agronomy Faculty of Agriculture Kasetsart University Bangkok
10900, Thailand, 1992-12-01.
several sustainability issues. Although the upward trend in yield has been maintained over the past three decades, the rate of increase is slackening, largely because of deteriorating soil fertility and the high incidence of pests and diseases associated with monoculture. The social impact of the Green Revolution has also sometimes been harmful. Since HYVS require high inputs such as fertilizer, irrigation water and pesticides, as well as intensive management, large landowners with plenty of capital were the main beneficiaries. Attracted by the high returns which the new seeds made possible, landowners tended to begin farming their land directly, sometimes exacerbating the problems of landlessness and rural poverty.

Other types of technology which give high yields but have a negative impact on the environment, such as heavy applications of pesticides, monoculture, and extension of irrigation systems, have already been discussed. We must question how long our natural resources can meet the need for an increased output of agricultural commodities, before drastic degradation of the resource occurs and productivity falls even below its present levels.

**Bob Carlisle and Jonathan Wadsworth (2005)** state that Agricultural technology can affect smallholder income, labour opportunities for the poor, food prices, environmental sustainability, and linkages with the rest of the rural economy:

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Agricultural technology has been a primary factor contributing to increases in farm productivity in developing countries over the past half-century. Although there is still widespread food insecurity, the situation without current technology development would have been unimaginable.

New technology can provide additional rural employment, but there are always countervailing pressures to reduce labour input and lower its costs.

Food prices are demonstrably lower because of technology, but the distribution of benefits between consumers and producers depends on the nature of the local economy and trade patterns.

The adoption of technology requires adequate incentives for producers. Investments in labour or cash will not be made unless there are adequate returns. One of the most important supporting factors is the adequacy of markets for outputs and inputs.

Although there is much academic debate regarding the nature and impact of technological change, the important issues for development assistance agencies are related to other uncertainties. These include:

1. identifying the most effective planning procedures for directing agricultural technology to poverty reduction;
2. establishing the role of agriculture in national development strategies;
3. deciding the degree to which agricultural investments are appropriate for marginal areas;
4. identifying the correct mix of public, private and civil society support to agricultural technology generation;

5. and identifying the types of technology that warrant support.

Because agricultural technology addresses multiple, and at times conflicting, objectives, there is a need for careful planning. But there is a trade-off between investment in micro-level technology screening, on the one hand, and support to basic institutional capacities and political responsiveness, on the other. The rhetoric of technological revolutions should be eschewed in favour of consistent attention to building technological capacity in response to changes in the rural economy. One of the most difficult choices is that facing the appropriate level of (agricultural) support for poverty reduction in marginal areas. An important challenge is marshalling sufficient (and coherent) support for public research and extension in the face of severe constraints in development budgets. Private sector technology generation (and technology delivery) is of growing relevance to poverty reduction strategies, but it is probably unreasonable to place high expectations on vastly expanded formal public-private partnerships. Support to NGOs in agricultural technology generation should focus on their role in building local institutions and capacities; a strong rural civil society is essential for articulating technology demand.

There are no easy rules for guiding investments in particular types of technology, and pragmatic, case-by-case analysis and follow-up is required.
Much current rhetoric (e.g. related to biotechnology or low external input agriculture) does little to promote responsible policies.

Among the most important **policy challenges** related to support for agricultural technology are:

- the identification of an effective investment portfolio of technologies;
- structuring interchange among producers, consumers, public institutes (national and international), civil society and the private sector to elicit effective pro-poor demand;
- structuring assistance to recognise the long-term, incremental nature of technology generation;
- locating technology policies in a wider policy arena; and
- setting and articulating clear policy goals that relate technology generation to food price, labour, trade, and regional development.

There are a number of implications for the way that donor assistance to agricultural technology is structured. The agencies need to develop in-house capacity to monitor the processes and outcomes of agricultural technology generation. This implies a commitment to developing institutional memory and to coordinating central syntheses and guidance with country-level experience. Policies in support of agricultural technology generation should place strong emphasis on local institution building and should see that agriculture is addressed in a coherent fashion in poverty planning. An understanding of the multiple impacts and second-order effects of technology should inform the
policy process. Finally, donor agencies need to increase their collaboration and co-ordination in support of technology generation.

Chithra (2008)\textsuperscript{147} pointed out when employment and income become the goals of agricultural development, conservation of forests, a check and reversal of environmental degradation of soil and crop diversification and export for commercialization of farm production and processing for value addition are the proactive strategies. Export led growth of agriculture is possible in Tamil Nadu and it demands a drastic revision of priorities as outlined above. A market oriented production is consistent with export-led growth policy, but the market must be efficient requiring limited intervention by the government. Such a strategy is absent and that is the weakest sport in agricultural development plans and programmes.

Agricultural development in Tamil Nadu needs a comprehensive planning with emphasis on up trend in farm income through improvement in productivity of crops, price-policies favouring cost price-parity, commercialization, efficient markets and export of value added products meeting international quality standards. It is the best strategy to guide policies and programmes to bring about export led growth of agriculture in Tamil Nadu. It will benefit both farmers and farm labourers, with minimal need for government intervention. A high growth rate of agricultural income is a guarantee for removal of poverty and economic growth of the State, because

\textsuperscript{147} Dr. N. Chithra (2008) Agriculture in Tamil Nau problems and prospects, Kisan world, Vol.35, No.2, p.48
agricultural sector has the largest percentage of the poor and also has strong forward and backward Sectoral linkages.

Kumar (2008)\textsuperscript{148} pointed out that the globalization agreement on Agriculture provides for new opportunities for increased international trade in Agriculture. Globalization was felt that the disciplines of GATT, which traditionally focused only on import access problems, should be extended to measure affecting trade is agriculture, including domestic agricultural policies and the subsidization of agricultural exports. It was felt necessary to reform agricultural policies in order to achieve trade liberalization in agriculture. The idea was to progressively reduce trade distorting subsidies, improve import access and curb export subsidies in agriculture. Under the agreement on Agriculture the main countries would have to reduce drastically subsidies granted to the farm sector.

Vanitha and Anitha Rexalin (2008)\textsuperscript{149} states that agriculture is the largest and most important sector of the Indian economy. But this sector remains most backward and about 40 per cent of rural population remain below the poverty line. Much of the rural population does not have access to common infrastructure like connectivity, electricity, health and safe drinking water. Complex characteristics of rural India include inaccessible terrain and dispersed villages, sub optimal utilization of natural resources, lack of

\textsuperscript{148} Dr. S. Kumar (2008), Indian Agriculture and the Globalization, Agriculture under Globalization, Dominant Publishers and Distributors, New Delhi – 2, p.10.

\textsuperscript{149} Vanitha and Anitha Rexalin (2008), Agriculture and Globalization, Agriculture under Globalization, Dominant Publishers and Distributors, New Delhi – 2, p.55.
extension of adequate privileges are detrimental to the socio-economic environment in India. Imbalance in socio-economic development and rural urban divide can be removed if the infrastructure in rural areas is made adequate, qualitative and a growth oriented business environment is created. This in turn can generate employment opportunities.

Raja Mohammed (2009)\textsuperscript{150} views that Reduction and especially, elimination of agrochemical require major changes in management to assure adequate plant nutrients and to control crop pests. As it was done a few decades ago, alternative sources of nutrients to maintain soil fertility include manures. Sewage sludge and other organic wastes, and legumes in cropping sequences. Rotation benefits are due to biologically fixed nitrogen and from the interruption of weed, disease and insect cycles. A livestock enterprise may be integrated with grain cropping to provide animal manures and to utilize better the forages produced. Maximum benefits of pasture integration can be realized when livestock, crops, animals and other farm resources are assembled in mixed and rotational designs to optimize production efficiency, nutrient cycling and crop protection.

Gopalasundar (2010)\textsuperscript{151} stated that Increasing trend of custom hiring of high value implements. Mechanisation taking place for the following crops Pady – threshing, reaping and harvesting. Transplanting is going slow, Potato –

\textsuperscript{150} Raja Mohammed (2009), Modern Agriculture and Sustainable Farming, Peninsular Economist, Vol. XXI, No. 1, Pp.234-235.

planting and digging, Wheat – harvesting and Soil preparation – rotary tillers. Decreasing availability and high cost of labour forcing to move towards mechanization. Increasing awareness about better quality, high productive and trouble free functioning of implements (value for money). Multiple use of tractor and implements (i) Exposure of farmers to global hybrid seeds, highly efficient agro chemicals and micro-irrigation systems. (ii) World’s major agro inputs players are being attracted to India, the largest source of genetic material (gene pool) of crops for research in biotechnology.

**Gopalasundar (2009)** pointed out that Development of tractors (prime mover) will primarily be based on well defined and pre-envisaged applications. Over a 10-year time period, the tractor market in India will be similar to that of some of European countries. With continuous land consolidation, rise in labour rates, and the subsidies offered by the Government for larger farms, there has been a continuous shift towards high HP tractors. Portugal is the only country in the European Community where tractors of below 60 HP capacity are used for farming. Western European countries like the U.K. have average tractor capacity of 119 HP. The average sophistication level in India over the next ten years will be on the rise, though price realization per additional feature will not go up in proportion. To address the various customer needs manufactures will provide different types of tractors that are application specific. Broadly the products can be segmented into: compact tractors, articulate tractors and utility tractors.
R. Gopalasundar and N. Chithra (2010) stated that technologies played a major role to bring the horticulture to limelight. The various steps taken up government and non-government organizations involved in promotion of horticulture will further help to focus on the role horticulture can play in the overall agricultural productivity and in meeting nutritional needs of the population so vital for its health and future of the country.

Increasing Profitability to Farmers: In addition to increasing the productivity per unit area, higher benefit to cost ratio must be ensured. While technologies aimed at increasing the input use efficiency reduce the cost of off-season production and export promotion increase the benefit – all leading to higher benefit : cost ratio.

(i) Enhancing the input use efficiency: In the changing horticulture scenario, unless cost and quality competitiveness are given due emphasis, farming in India will be at cross roads.

Raja Mohammed (2010) stated that in India is making a substantial surge in the GDP growth. We are contemplating a 10 per cent + increase with euphoria. Among the major sectors, namely, agriculture, manufacturing and services. The main GDP growth is due to manufacturing and services. In spite of the meagre 2.1 per cent growth in agriculture, we are still able to achieve a substantial increase in GDP largely because of manufacturing and services.

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Apart from GDP growth, a populous nation like India which constitutes about 1/6\textsuperscript{th} of the human race – has to think seriously about food security for its future. The food habits are also changing fast. In the past, the priority was to feed million of poor people at least one square meal a day. Today, the priorities are changing. More affluence, resulting out of the GDP growth, has paved the way for more successful people to look for variety and quantum, which has in turn increased the demand for supply of food.

We have to educate people to develop multiple skills in using agricultural equipment. This will also help the work force to get better pay and hence result in prosperity. Unfortunately from agriculture to manufacturing, we have too many specialists in India and multi-skills are lacking.

In the field of dairying the first revolution in the 60’s has ensured the survival of several millions of people. Today India stands ahead of any other country producing 91 million tonnes of milk but productivity fares much below any other country of repute. 5 million animals in France produce 24 million tonnes of milk per annum and India produces 91 million tonnes with 70 million animals. Not that we have to match France or Germany, but better productivity is definitely possible with the existing setup by educating farmers, using better tools and creating awareness of modernization and mechanization of even small farms.
Ishwar C. Dhingra (2010)\textsuperscript{154} has pointed out that the improved strains of seeds are essential for increasing agricultural production. Unless the farmer has good seeds of suitable varieties, he cannot get the best out of other inputs, such as irrigation, fertilizers, insecticides and machinery. With HYV seeds, it becomes possible for him to take to intensive agriculture because of the resultant high yield and good economic returns. When one sees in retrospect, it becomes clear that much of the stagnation that prevailed in India agriculture till the mid–1960’s could have been explained in terms of the availability of poor and low-yielding variety seeds.

Rathidevi. R (2012)\textsuperscript{155} stated that in AIC believes technology will play an important role in crop insurance. The main role we envisage is para-metric insurance, objective loss assessment, and timely payment of indemnities. It is certain that the technology would help in rolling out farmer friendly insurance covers in future.

\textsuperscript{154} Ishwar C. Dhingra (2010). The Indian Economy, Environment and Policy, Sultan Chand and Sons, Educational Publishers, New Delhi, Chap. 13, p.312.