Pattern of farm level capital formation and its impact on the farm production efficiency: An economic analysis in two contrasting regions of Karnataka state, India

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Abstract

A study on farm level capital formation in two contrasting scenarios of agricultural development revealed that by and large capital formation was more on large and irrigated farms. The aggregate capital formation was higher in the progressive area than in less progressive area. The priority of investment was more on irrigation development. In the less progressive area, among rainfed farms, investment was more on livestock and perennial crops. The mean technical efficiency was higher in the more progressive area among all types of farms vis-à-vis less progressive area as a result of higher capital formation on productive assets.

Sustained investment on productive assets in agriculture by both farmers and the state is a pre-requisite for enhancing agricultural growth and incomes of farmers. While public investments aim at creating assets and infrastructure in the form of public irrigation, roads, markets and other common facilities at macro level which are essential and complimentary for private investment on capital assets by farmers, private investment at farm level by farmers is largely for the creation of productive assets.

Capital formation in agriculture in India has a evoked serious debate especially during 1990s and this is continued in this decade also (Rao 2005: Chand and Kumar, 2004) reflecting its importance in agriculture growth and development. There has been a serious concern regarding declining trend in public investment in agriculture as debated at various levels by policy maker and economists. While there has been lot of research on various dimensions of public capital formation at aggregate level, not much attention has been given to dynamics of private capital

formation especially at farm level over time scale and space. Perhaps this could be partly due to cost and constraints associated with collation of farm level data over time and space.

Interestingly lot of debate has been stirred up on the complementary relationship between public and private investment in agriculture. As opined by Chand and Kumar (2004) that there has been a hazy relationship between public investment and its effect on complementary and private investment in the country. Perhaps this hazy relationship may be due to lack of convergence in the development of dry land and irrigated agriculture as influenced by varying levels public investment between the two.

Starting from early eighties, a paradigm shift is evident in the structure of farm enterprises such as conversion of annual dry land crops into perennial enterprises; irrigated cereal crops to commercial and high value crops like, vegetables, fruits and other crops. However, after 1990's, the diversification of farm activities especially in the areas of poor irrigation development at farm level has led to emergence of dry land horticulture and livestock activities in the Country. These sectors need substantial amount of capital investment particularly for ensuring protective irrigation in addition to investment on various components of the two sectors. Coupled with this, the development of economic reforms and associated positive impacts on value addition and exports seem to have encouraged farm diversification. Non-availability of labour has forced forced farmers to shift their cropping system from labour intensive ones to less labour intensive enterprises, which further call for higher capital investment on newer equipment and technological inputs.

These transformations are also influenced partly by the state support in the form of development initiatives and farm technologies from agricultural universities. It is interesting to examine whether, these paradigm shifts in crop enterprises are influenced by farm level investment. Whether, these changes are uniform across different developmental regimes as denoted by varying level of capital formation could be of interest from policy point of view. Though lot of evidence on impact of public investment in agriculture at macro-level is evident, it is not very clear as to what is the pattern of capital formation at farm level. In fact studies dealing with farm level capital formation are few and far between. Further, studies on influence of various government sponsored programmes like subsidized credit for irrigation development, farm machinery and equipment, subsidy for water saving devises/technologies (Sprinkler and

Drip) and role of subsidized credit on capital formation are lacking. Despite strong government support in the form of various programmes and subsidies, the farm productivity remains very low. Perhaps it may be due to the vicious circle of low productivity in which case it can be inferred that meaningful investment on productive capital assets has not come forth. Continuous investment on new capital assets and replenishment of existing capital stock on farm is essential for sustaining agricultural growth as capital assets depreciate continuously due to use and time obsolescence.

From the policy point of view it is highly useful to assess the pattern of private capital formation on the farm. This will give an idea of farmers' priority in the farm development; whether they are viewing capital formation as a strategy for long term development?. Further such analysis also reveals the pattern across different types of farms and impediments they face in capital formation on the farm. In addition results of this type will also help in reorienting state farm programmes to suit the changing agrarian needs of farmers. Hence, the study seeks to address micro level capital formation in two contrasting scenarios of developed and less developed regions and concomitant impact of capital formation on technical efficiency of farms.

Methodology:

Sampling framework

The study was carried out in the Eastern Dry Zone (EDZ) of Karnataka state (Zone-5), which presents highly contrasting scenarios of the most developed areas and most backward regions. These contrasts provide us an opportunity to examine influence of capital formation on the development of agriculture.

Two *taluks* (a secondary level administrative unit) namely Kolar and Magadi representing progressive and less progressive areas, respectively were purposively selected for the study. Kolar taluk is highly progressive one with respect to agriculture as lot of investment has gone into creation of farm assets. On the contrary, Magadi taluk is less progressive with respect to agricultural development. However, both have almost similar geographical features such as quality of land, topography, soil type, fertility and climatic factors. Both the regions are located at about 40-60 kms away from Bangalore in opposite directions. Using seven indicators of development, namely, cropping intensity, area under commercial crops, area under irrigation,

number of credit institutions, net irrigated area, number of tractors per hectare of gross cropped area and institutional credit per hectare, all the *taluks* in the zone were ranked to form a composite index. Kolar and Magadi *taluks* among 17 *taluks* of the zone ranked the first and the last based on the index and accordingly they were considered as most developed and least developed taluks. Enterprises of finger millet, mulberry, fruits and vegetables occupied a larger area in Kolar taluk accounting for 39.15, 18.59, 11.04 and 14.28 per cent of the total gross cropped area (GCA). On the contrary finger millet, paddy, redgram and fruits occupied more area in Magadi taluk accounting for 55.96, 3.00, 3.16 and 13.30 per cent of the total GCA of the taluk.

Sampling frame

The sampling design consisted of a multistage random sampling procedure. The first stage consisted of selection of taluks in the zone as described earlier. In the second stage two to three villages were selected randomly in each hobli covering both small and large farms. Thus, 14 villages from 7 hoblies of Kolar taluk and 12 villages from 5 hoblies of Magadi taluk were selected. In the final stage of sampling, sample farmers were selected randomly from these villages to constitute a pre determined sample size of 160 farmers. From the list of farmers of the selected villages which was obtained from the state department of agriculture and the revenue officials of the respective villages, a sample of 80 farmers each from the two taluks comprising 40 small farmers and 40 large farmers was selected. Thus a total of 160 farmers were selected randomly.

Sample farms were categorized as small and large based on the size of holding. Farms with a total area of 2 ha or below were categorized as small farms and those with more 2 ha were treated as large farms. The sample farms were post classified as rainfed and irrigated farms based on the nature of holding. Farms which were solely rainfed or dependent on rainfall for agricultural activities were classified as rainfed farms. The farms which had irrigated area along with or without rainfed area were classified as irrigated farms. The same criteria were applied to both the progressive and less progressive taluks to classify respondent farmers. Thus, there were 4 groups each in progressive and less progressive areas, namely, small, large, rainfed and irrigated farms.

Collection of data

Detailed data from the respondents were collected through personal interviews from the head of the each selected household in a pretested structured schedule. The necessary information on capital investment on various assets was collected for the period 1998-99 to 2007-08. The data on cost and returns of crops and livestock enterprises were collected for the year 2008-09. Primary data collected consisted of the following aspects; general socio economic information of the respondents, detailed information regarding amount and year of investment, cost of acquisition of assets of land, farm buildings, farm machinery and equipment, improvement on land, investment on perennial crops, irrigation structures and equipment and livestock. In addition, information on cropping pattern, cost and returns of crop and livestock enterprises was also collected. In the present study only gross capital formation was considered.

Analytical techniques

The actual cost incurred by the respondents in acquiring new capital assets was considered for the study period from 1998-99 to 2007-08. The capital investments made on various assets over the years were expressed at 2008-09 prices by considering the whole sale price index to account for inflationary effects. This process brings investment over the years to the current period. The following procedure was adopted to bring values of capital asset to current prices (2008-09).

Considering the wholesale price index (WPI) of all commodities for the period 1993-94 to 2008-09 the new index was prepared by splicing the index values keeping the base year as 2008-09. This is done as given below by dividing the wholesale price index values of i^{th} year with the base year price (2008-09) and multiplied by 100.

$$\text{Index with base year 2008-09} = \frac{\text{WPI value of } i^{th} \text{ year}}{\text{WPI value of base year 2008-09}} * 100$$

By using the above index with 2008-09 as base year, all values of capital assets were updated at current prices of 2008-09 by dividing the capital asset values with the respective index value (corresponding year) and multiplied by 100, as given below.

$$\text{Current values of capital assets (at 2008-09 price)} = \frac{\text{Capital asset value in } i^{th} \text{ year}}{\text{Index value of } i^{th} \text{ year with 2008-09 as base year}} * 100$$

For assessing the technical efficiency of farms as influenced by magnitude of capital formation, eight crops were selected considering the number of farmers cultivating those crops in both progressive and less progressive areas. The selected eight crops were finger millet, paddy, beans, potato, tomato, cabbage, cucumber and mulberry.

Economics was worked out for all the selected crops and they were pooled together to form a single value to represent farm as a whole. Finally all the costs and returns were considered per ha basis in rupees for the technical efficiency analysis.

Frontier production function analysis

To assess the technical efficiency of farmers in both the regions, the frontier production function approach was used. The frontier production function captures the ability of farmers to achieve the maximum realizable crop outputs with minimum level of inputs under both the existing situation and given technologies. Technical efficiency evaluates the farm's ability to obtain the maximum possible output from a given set of resources.

In the present study, a Cobb-Douglas type of production function was used. But the Cobb-Douglas production function does not discriminate technical and allocative efficiencies. It ignores the problem of technical inefficiency by assuming that all the techniques of production are identical across farms and every farmer is technically efficient which many a time is not true. To overcome this limitation the concept of efficiency introduced by Farrel (1957) was used. The frontier production function based on this concept distinguishes technical and allocative efficiencies. As Farrel proposed the efficiency need to be measured in relative terms, as deviation from the best performance in a representative peer group. Later Timmer (1971) modified this procedure and came out with a Cobb-Douglas type of specification on the frontier which paved way for the evolution of an output based measure of efficiency.

The regression function in the log form will be

$$lnY = A + \sum_{i=1}^{n} \beta_i lnx_i + U \qquad U \leq 0$$

The above model was estimated using Corrected Ordinary Least Squares (COLS) regression. Initially the regression function was estimated using Ordinary Least Squares (OLS) to get best linear unbiased estimates of **βi** coefficients. The function estimated was in the form,

$$Y = aX_1^{b1} X_2^{b2} X_3^{b3} X_4^{b4} U$$

Where,

Y = Gross returns obtained from the selected crops (Rs. /ha.)
a = Intercept, a scale parameter
$\mathbf{X_1}$ = Seed (Rs. /ha.)
$\mathbf{X_2}$ = Manure and fertilizer (Rs. /ha.)
$\mathbf{X_3}$ = Plant protection chemicals (Rs. /ha.)
$\mathbf{X_4}$ = Labour (Rs. /ha.)
U = Error term

bi = Output elasticities of respective inputs or independent variables. The summation of b_i coefficients gives returns to scale.

The above equation was estimated using Ordinary Least Square method. The frontier production function was derived from the estimated Cobb-Douglas production function fitted to the gross returns from crop cultivation; the technical efficiency was worked out using potential output that can be realized from a set of inputs. The potential gross return is given by

$$\mathbf{Y^* = Y + e_m}$$

Where,

$\mathbf{Y^*}$ = Potential gross return that could be derived from crop cultivation.

Y = Estimated gross return from crop cultivation.

$\mathbf{e_m}$ = Highest positive error term.

The intercept estimate **'a'** was then corrected by shifting the function. The intercept estimate was corrected such that no residual is positive and one becomes zero. This was done by adding the largest error term of the fitted model to the intercept. With the shift in the intercept the new production function obtained gives the maximum gross return obtainable for a given level of input. It would be of the form

$$lnY^{*} = A + \sum_{i=1}^{n} \beta_i lnx_i + U \quad , \qquad U \leq 0$$

If the value of β_i is negative, then the geometric mean of **i**th input x_i is taken instead of β_i **ln** x_i. The frontier production function was estimated for both progressive and less progressive areas taken together.

Timmer's measure of technical efficiency

It derived as the ratio of actual gross returns to the potential gross returns on the production function, given the level of input use on the **i**th farm.

$$\text{Technical efficiency of } \mathbf{i}^{th} \text{ farm} = \frac{\mathbf{Y_i}}{\mathbf{Y_i^{*}}}$$

Where,

$\mathbf{Y_i}$ is actual gross return from crop cultivation on **i**th farm

$\mathbf{Y_i^{*}}$ is the potential gross returns attainable from crop cultivation on **i**th farm

For the most efficient farmer (**Y= Y*),** the technical efficiency will be maximum (i.e. =1). The frontier approach infers that a producer is technically efficient if the observed gross return is maximum for a given level of input. Thus, the production frontier is defined as the locus of maximum possible gross returns for each level of input used. The technical inefficiency denotes the failure of a firm to produce the frontier level of gross return at a given input level.

RESULTS AND DISCUSSION

Capital formation in agriculture is a crucial component of agriculture growth and development. Hence, it is a priority issue and much-debated one by policy makers, researchers and others. Capital formation assumes a greater significance in view of need for infusing newer capital in agriculture because capital stock on the farm gets depleted (depreciated) over time due to use and wear & tear. In order to sustain current growth and increase the production potential of the farm, it is essential to add new capital assets and replenish existing assets. In the subsequent sections after a brief account of socioeconomic features of respondents, a detailed discussion on capital formation and technical efficiency will follow.

Socio- economic features of different categories of farmers

Analysis of socio-economic profile of respondent farmers will enable us to infer the cause- effect relationship in capital formation as capital investment is a function of not only economic factors but also a function of an array of sociological and personal factors. The average size of holding was 2.64 ha and 2.04 ha in the pooled group of progressive and less progressive areas, respectively. The holding size was lower on small and rainfed farms and it was above the average of pooled group on the large and irrigated farms in both the regions.

The average irrigated area was 41.83 and 25.36 per cent of farm size in pooled category farms in both the areas. The higher percentage of irrigated area in progressive area was obviously due to larger capital investment on irrigation structures.

The respective average area under commercial crops was 61.12 and 37.32 per cent of gross cropped area in the pooled category of farms in both the areas. The lower area under commercial crops on small and rainfed farms was due to their small size of holding, allocation of larger area for cereal crops to meet the food requirement of families and lower proportion of irrigated area.

The average cropping intensity in progressive and less progressive areas was 201.85 and 157.19 per cent, respectively. Among small and rainfed farms, the cropping intensity was much lower than that of large and irrigated farms. Higher capital formation on the farms is expected to result in higher farm income. Keeping this aspect in view, the annual income of respondents from different sources was elicited. Among farmers in progressive area, the average annual income was Rs. 2,70,553 per farm among pooled farms. The major source of income was crop enterprises on small, large and irrigated farms with 52.97, 57.16 and 59.27 per cent respectively, and it was through livestock enterprises in rainfed farms (26.65%).

In the less progressive area, the average annual income was Rs. 1, 30,602 per farm in pooled category. Interestingly, crop enterprises turned out to be the major source of income in less progressive area, followed by livestock enterprises with 34.29 per cent. Livestock enterprises contributed substantially to farm income for small and rainfed farms with 40.48 and 55.67 per cent, respectively.

The small holding size and lack of irrigation forced the rainfed farmers to depend heavily on livestock enterprises in both progressive and less progressive areas. In the progressive area,

due to higher capital formation, farmers were able to take up commercial crops particularly vegetables and perennial crops.

Vegetables and perennial crops dominated the cropping pattern in progressive area especially on large and irrigated farms and to some extent on small farms also. However, among rainfed farms, cereal crops dominated with 68.53 per cent of area.

In less progressive area, cereal crops dominated cropping pattern (44.29%) followed by rainfed perennial crops (22.06%) Emphasis on cereal crops in less progress area was largely due to inadequate capital assets especially irrigation facility. Thus, results strongly reiterate the fact that higher capital formation on farms contributes to the increased magnitude of cropping intensity and in turn higher income.

Pattern of capital investment on different types of farms

The pattern and magnitude of capital investment on individual farms depends on magnitude of incomes of farmers, availability of credit and technical knowledge of the farmer. The capital investment occurred on the selected farms during the period 1998-99 to 2007-08 was considered for the study and they are expressed in 2008-09 prices. It is hypothesized that the magnitude of capital formation is higher in the progressive area than in less progressive area. Results showed that major investment was on irrigation structure and equipments across all type of farms, but it was on livestock on rainfed farms in less progressive area (Tables 1 and 2). The aggregate capital formation in the progressive area was twice more than the magnitude of less progressive area. It was Rs. 7, 37,165 per farm in progressive area as against Rs. 2, 51,224 in the less progressive area during the reference period.

In both the areas, the priority of investment was more or less on irrigation structures as 37 (Rs. 276237) and 40 per cent (Rs. 101396) of total investment was made on this component. This finding was according to our hypothesis that irrigation is the basic resource of the crop production, hence farmers accorded top priority for this purpose. Among different types of farms, the average investment was highest on irrigated farms in progressive area with a value of Rs. 3,81,017 as against Rs. 2,25,324 among irrigated farms in the less progressive area. The findings imply that irrigation is a major component of capital formation which enables farmers to take up commercial and high value enterprises (tables 1 and 2).

An interesting and conspicuous result that emerged from the study was that among rainfed and small farms, livestock was the most preferred capital asset. About 43 per cent of total investment among rainfed farms in the progressive area was on livestock. For their less progressive area counterparts, it was 48 per cent. As scope for development of irrigation facilities is low in rainfed farms, these farmers preferred livestock enterprises to sustain their livelihoods. Further, mostly small farmers preferred livestock enterprises in the form of milch cows, sheep, etc. for which institutional finance is readily available.

In the less progressive area, due to lack of irrigation facilities, the investment on dry land horticultural crops (perennial crops) was considerable at 13 per cent as against 3 per cent in the progressive area. About 16 per cent each by large farms and rainfed farms and about 13 per cent in irrigated farms in the less progressive area was devoted towards perennial enterprises notably to mango enterprises. Perhaps non-availability of labour for annual crops and availability of institutional finance for perennial crops might have encouraged these farmers to go for perennial enterprises.

Although there was not much difference with respect to percentage of investment on purchase of land and irrigation structures between the two regions, but when we examine the investment per ha basis there was a wide gap between the two regions. Small farmers invested relatively higher amount per ha on farm buildings (mainly for sericulture) and livestock. The results in conformity with those of Mruthyunjaya (1972) who noticed that agricultural investment was more on small farms (79 % of total investment) than on large farms (59%) in Karnataka.

In the progressive area, among various capital items, about 28 per cent of total investment was made on farm buildings. Interestingly, small farmers made higher per cent of investment on this asset to the extent of 40 per cent. Similarly, higher allocation to this asset among other types of farmers was also noticed in the region. The reason for high investment on these assets was the predominance of sericulture in this area which needs an exclusive building to rear silkworm scientifically for better quality and yield of cocoon. In addition, government also encourages construction of sericulture buildings by way of subsidies, hence, higher investment on farm buildings.

While, the proportion of investment was evenly distributed on various farm assets on irrigated farms, rainfed farms had concentrated more on livestock, farm buildings (cattle shed)

and rainfed perennial crops (mango and eucalyptus). Chaudhari (1970) in West Bengal, Hiremath (1973) in Belgaum district (Karnataka), Jagadeesha Murthy (1983) in Karnataka and Rai *et al*. (1972) in Haryana state observed similar pattern of investment between irrigated and rainfed farms.

A comparison between small and large farms in the less progressive area showed a considerable difference in the pattern of investment between the groups. The large farms had invested 2.7 times higher amount on productive assets as compared to small farms. The major investment on large farms was on irrigation structure and equipments followed by perennial crops and farm buildings, while in small farms it was on irrigation structures and equipments followed by livestock and farm buildings. While the investment was fairly well distributed on various assets on irrigated farms, the rainfed farms had concentrated more on livestock and farm buildings.

Economics of crop production and technical efficiency of farms

A high level of capital formation on farms should result in higher income because of development of productive assets, irrigation facility and higher production efficiency in the farm business. All these positive transformations due to capital formation should culminate in higher productivity and net income. It is hypothesized that higher the level of capital formation, the larger is the net income of the farms. In order to test this hypothesis, economics of crop production for farm as a whole unit was assessed for both the areas. The common major crops cultivated by the respondents during the year 2008-09 in both the areas were considered.

Costs and returns in cultivation of major crops (per hectare)

On the aggregate, all economic measures of cost of production, gross and net returns and gross returns per rupee of total cost among pooled farms per ha were higher in the progressive area than in the less progressive pooled farms (table 3 and 4). The major reason for higher income in progressive area was that about 60 per cent of area in progressive area was under commercial crops. But the area under commercial crop in less progressive area was only 37 per cent of the total area. Concentration on commercial crops in progressive area could be attributed to the productive assets and irrigation facilities created because of capital investment. The commercial crops consumed higher quantity of inputs and produced more output than the food crops in both the regions. Among all the costs, the variable cost was the major cost component

per ha in both progressive and less progressive areas. Among the variable costs, human labour per ha was the major variable cost component in both the areas. This was mainly due to existence of high wage rates in both the areas.

Between the two areas across all types of farms, costs and returns were higher wherever capital formation was higher as in the case of large farms and irrigated farms both in progressive and less progressive areas. Per ha costs and returns among small farms were higher in progressive area as compared to small farms in less progressive area. This was mainly due to higher quantity of inputs used in progressive area (variable cost Rs. 16,043 per ha) as compared to small farms in less progressive area. Identical results were also noticed in respect of irrigated farms in both progressive and less progressive areas. Higher costs and returns per ha among irrigated farms in progressive area were mainly due to higher per cent of area under commercial crops. In the aggregate, the average net income per ha was Rs. 74089 (US $ 1543.52) in progressive area as against Rs. 30865 (US $ 643.02) in less progressive area indicating the influence of capital formation on farms in progressive area. Thus, our hypothesis that as the magnitude of capital formation is higher, the productivity and incomes tend to be higher is proved.

Technical efficiency of farm production in the two regions

Technical efficiency is defined as the ability of a farm to produce maximum possible output with the given quantity of inputs and technology as defined by Kalirajan and Shand (1994). It can be achieved by adopting the best practice /technique, which involves most efficient use of inputs, technology and other resources. For detecting the technical efficiency of farms in cultivation of major crops, the frontier production function was used and estimation was done by means of Corrected Ordinary Least Square (COLS). Results of the frontier production function are presented in table 5. The adjusted R^2 was high at 0.9775 indicating a very good fit to the data. The inputs seed, manure & fertilizer, PPC and labour had a positive and statistically significant influence on gross return with elasticity coefficients of 0.1759, 0.3307, 0.0149 and 0.7007, respectively.

Magnitude of technical efficiency of different farms of progressive and less progressive area

The mean technical efficiency values were estimated for different types of farms of progressive and less progressive areas and results are presented in table 6. The mean technical efficiency of pooled farms of the progressive area was higher (49.06%) than that of pooled farms of less progressive area (34.58%). The difference in the gross returns between the two areas confirms the difference in the technical efficiency and it indicates that there was a scope for further improvement of yield in these areas by using higher levels of resources. Between small and large farms, the mean technical efficiency was higher in case of large farms than in small farms in both progressive and less progressive areas. However, among small farmers the mean technical efficiency was higher (38.86%) in progressive area as compared with small farms in less progressive area (27.00). But in general technical efficiency was lower among all categories of farm. This implies that farmers in general or not using best practices or methods for crop production. Thus there is a greater scope for rising farm income by reorganizing production methods and practices.

The mean technical efficiency between large farms was higher in progressive area (59.26%) than those of less progressive area (42.17%). This high difference in technical efficiency among large farmers in the two regions could be attributed to the size of holding, level of capital formation and type of crops grown. Almost same trend was observed between different categories of farms in the two regions that technical efficiency was higher in general in progressive area as compared to the less progressive area. The higher technical efficiency in progressive area was mainly due to their higher capital formation because of which larger area was under commercial crops and these farmers adopted best practices of crop production as compared to small farmers in less progressive area.

Further, the distribution of farms according to level of technical efficiency was examined and results are summarized in table7. Farms were categorized into three groups as high, medium and low efficiency groups. About 43 per cent of farmers in progressive area had high efficiency (more than 60% technical efficiency), where as in the less progressive area their percentage was only 13.75 per cent. In the less progressive area, more than 60 per cent of farmers were operating at very low level of efficiency that is less than 40 per cent. That means, they could realize only

40 per cent of maximum/potential income from their farms. Thus, there is scope for enhancing farm incomes by infusing additional capital on their farms.

Conclusion:

The capital formation as expected was higher in more progressive taluk of Kolar especially on the irrigation development among all types of farmers. However, as scope for irrigation development and farm mechanization is lower among small and dry land farmers, they may be encouraged to take up of dry land horticulture intensively for which support from the state need to be increased from the current levels. Further small farms may be encouraged to go for drip/sprinkler systems of irrigation for taking up horticultural enterprises with their meager irrigation resources. As resource endowment with small farmer is quite low, they need to give priority to livestock activities which they can easily adopt as financial institutions provide liberal capital (in the form of loans) for these activities.

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Table 1: Pattern of investment on different farm capital assets in progressive area

(Period: 1998-99 to 2007-08 at 2008- 09 prices)

(Rupees) (1 US $= Rs.48.00)

Assets	Small farms (N=40) (Av. area=1.09 Ha.)			Large farms (N=40) (Av. area= 4.20 Ha.)			Rainfed farms (N=22) (Av. area= 1.31 Ha.)			Irrigated farms (N=58) (Av. area= 3.15 Ha.)			Pooled farms (N=80) (Av. area=2.64 Ha.		
	Per farm	Per hectare	per cent	Per farm	Per hectare	per cent	Per farm	Per hectare	per cent	Per farm	Per hectare	per cent	Per farm	Per hectare	per cent
Purchase of and improvements on land	8990	8266	3	138039	32886	12	8035	6138	16	98351	31240	10	73514	27820	10
Farm buildings	140109	128836	40	265746	63311	24	9528	7279	19	276286	87758	28	202928	76794	28
Farm machinery and equipments	14870	13674	4	198663	47329	18	2590	1978	5	146282	46464	15	106767	40404	14
Live stock	37258	34260	11	68342	16282	6	21183	16181	43	64793	20580	6	52800	19981	7
Irrigation structure and equipments	143456	131914	41	409018	97443	36	-	-	-	381017	121024	38	276237	104536	37
Perennial crops	8136	7482	2	41704	9935	4	8268	6316	17	31236	9922	3	24920	9430	3
Total	**352820**	**324432**	**100**	**1121512**	**267186**	**100**	**49604**	**37892**	**100**	**997965**	**316988**	**100**	**737166**	**278965**	**100**
Ratio	1	1	-	3.18	0.82	-	1	1	-	20.11	8.36	-	-	-	-

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Table 2: Pattern of investment on different farm capital assets in less progressive area

(Period: 1998-99 to 2007-08 at 2008- 09 prices)

(Rupees) (1 US $= Rs. 48.00)

Assets	**Small farms** (N=40) **(Av. area**=1.07 Ha.)			**Large farms** (N=40) **(Av. area**= 3.02 Ha.)			**Rainfed farms** (N= 44) **(Av. area**= 1.64 Ha.)			**Irrigated farms** (N=36) **(Av. area**=2.54 Ha.)			**Pooled farms** (N=80) **(Av. area**=2.04 Ha.)		
	Per farm	**Per hectare**	**per cent**	**Per farm**	**Per hectare**	**per cent**	**Per farm**	**Per hectare**	**per cent**	**Per farm**	**Per hectare**	**per cent**	**Per farm**	**Per hectare**	**per cent**
Purchase of land and land improvements	8060	7551	8	58948	19519	15	6795	4153	11	66148	26026	14	33504	16393	13
Farm buildings	16225	15199	15	33821	11199	9	14093	8612	23	38382	15101	8	25023	12244	10
Farm machinery and equipment	2723	2551	3	39062	12935	10	1018	622	2	45184	17777	9	20893	10223	8
Livestock	25934	24294	24	48811	16163	12	29482	18017	48	47018	18499	10	37373	18286	15
Irrigation structure and equipments	49795	46646	46	152996	50661	39	-	-	-	225324	88652	47	101396	49613	40
Perennial crops	4677	4381	4	61394	20329	16	9996	6109	16	61194	24076	13	33035	16164	13
Total	**107415**	**100623**	**100**	**395032**	**130805**	**100**	**61384**	**37512**	**100**	**483250**	**190131**	**100**	**251224**	**122923**	**100**
Ratio	1	1	-	3.68	1.30	-	1	1	-	7.87	3.10	-	-	-	-

Table 3: Summary of costs and returns in cultivation of major crops in progressive area

(Rs./Ha.) (1 US$= Rs. 48.00)

Particulars	**Small farms** (**N**=40) (**Av. area**=1.09 Ha.)		**Large farms** (**N**=40) (**Av. area**= 4.20 Ha.)		**Rainfed farms** (**N**=22) (**Av. area**= 1.31 Ha.)		**Irrigated farms** (**N**=58) (**Av. area**= 3.15 Ha.)		**Pooled farms** (**N**=80) (**Av. area**=2.64 Ha.)	
	Amount	per cent	Amount	per cent	Amount	per cent	Amount	per cent	Amount	per cent
I. Costs										
1.Seeds	3792	5.07	6641	5.66	276	1.16	7090	5.74	5216	5.43
2.Fym (Rs.)	6289	8.40	7905	6.74	3449	14.46	8481	6.87	7097	7.38
3.Fertilizer (Rs.)	4780	6.39	7774	6.62	1724	7.23	8004	6.48	6277	6.53
4.PPC (Rs.)	3053	4.08	5185	4.42	0	0	5681	4.60	4119	4.29
5.Human labour	13891	18.56	19358	16.50	5597	23.47	20807	16.85	16624	17.30
6.Bullock and Machine labour	6238	8.33	6894	5.87	4330	18.15	7414	6	6566	6.83
8.Repair and maintenance charges	508	0.68	1262	1.08	128	0.54	1172	0.95	885	0.92
7.Insterest on working capital @ 9% per annum	2402	3.21	3613	3.08	539	2.26	3944	3.19	3007	3.13
9.Total variable cost	40953	54.71	58631	49.96	16043	67.27	62594	50.68	49792	51.81
10.Total fixed cost	21968	29.35	33086	28.19	6351	26.63	35560	28.79	27527	28.64
11.Total Marketing Cost	11938	15.95	25635	21.84	1456	6.11	25360	20.53	18787	19.55
12.Total cost	74860	100	117353	100	23850	100	123514	100	96106	100
II. Returns										
1.Gross return	1,23,929		2,23,553		34,474		2,26,566		1,70,196	
2.Net return	49,069		1,06,200		10,624		1,03,052		74,089	
3 Net Return (US$)	**1022.27**		**2212.50**		**221.33**		**2146.92**		**1543.52**	
4.Gross return for rupee of cost	1.66		1.90		1.45		1.83		1.77	

Table 4: Summary of costs and returns in cultivation of major crops in less progressive area

(Rs./Ha.) **(1 US $= Rs. 48/.00)**

Particulars	**Small farms** (**N**=40) **(Av. area**=1.07 Ha.)		**Large farms** (**N**=40) **(Av. area**= 3.02 Ha.)		**Rainfed farms** (**N**= 44) **(Av. area**= 1.64 Ha.)		**Irrigated farms** (**N**=36) **(Av. area**=2.54 Ha.)		**Pooled farms** **(N=80) (Av. area=**2.04 Ha.**)**	
	Amount	**per cent**	**Amount**	**per cent**	**Amount**	**per cent**	**Amount**	**per cent**	**Amount**	**per cent**
I. Costs										
1.Seeds	694	1.86	1891	3.08	299	1.31	2507	3.07	1293	2.62
2.Fym (Rs.)	4283	11.48	4810	7.84	3271	14.35	6105	7.47	4547	9.22
3.Fertilizer (Rs.)	1924	5.16	3707	6.04	1410	6.18	4534	5.55	2816	5.71
4.PPC (Rs.)	647	1.74	1182	1.93	_	_	2028	2.48	915	1.85
5.Human labour	7694	20.63	11107	18.10	5231	22.94	14497	17.73	9401	19.06
6.Bullock and Machine labour	4541	12.18	4552	7.42	4127	18.10	5059	6.19	4546	9.22
8.Repair and maintenance charges	316	0.85	734	1.20	106	0.47	1036	1.27	525	1.06
7.Insterest on working capital @ 9% per annum	856	2.30	1215	1.98	502	2.20	1688	2.07	1036	2.10
9.Total variable cost	20,955	56.19	29199	47.59	14,946	65.56	37454	45.82	25077	50.84
10.Total fixed cost	11206	30.05	17430	28.41	6329	27.76	24082	29.46	14318	29.03
11.Total Marketing Cost	5135	13.77	14730	24.01	1523	6.68	20211	24.72	9933	20.14
12.Total cost	37296	100	61359	100	22799	100	81747	100	49327	100
II. Returns										
1.Gross return		57,097		1,03,287		31,984		1,39,113		80192
2.Net return		19,800		41,929		9,186		57,366		30865
3.Net return (US$)		**412.50**		**873.52**		**191.38**		**1195.13**		**643.02**
3.Gross return for rupee of cost		1.53		1.68		1.40		1.70		1.63

Table 5: Results of production function analysis (elasticities) of major crops under both progressive and less progressive area taken together

Variable	Elasticity coefficient	Standard error	t- value
Dependable variable Gross return in Rs. per hectare (N=160)			
Independent variables			
Seeds (Rs. /ha.) (X_1)	0.1759***	0.0272	6.4727
Manure and Fertilizer (Rs/ ha.)(X_2)	0.3307***	0.0585	5.6566
PPC (Rs. /ha.)(X_3)	0-0149***	0.0054	2.7458
Labour (Rs. /ha.)(X_4)	0.7007***	0.0587	11.940
Intercept	0.2690	0.1841	1.4617
∑bi	1.2222		
R^2	0.9775		
F	1686.54		

Note: ***, **, * = significant at 1, 5, 10 per cent level of probability, respectively.

Table 6: Magnitude of technical efficiency in cultivation of major crops

Holdings	Technical efficiency	
	Progressive area	Less progressive area
Small farms	38.86	27.00
Large farms	59.26	42.17
Rainfed farms	18.80	18.22
Irrigated farms	60.54	54.58
Pooled farms	49.06	34.58

Table 7: Distribution of farmers according to technical efficiency

Particulars	Progressive area		Less progressive area	
	Number	**%**	**Number**	**%**
High efficiency group (Above 60 %)	34	42.50	11	13.75
Medium efficiency group (40 to 60 %)	15	18.75	21	26.25
Low efficiency group (Below 40 %)	31	38.75	48	60.00
Total	**80**	**100.00**	**80**	**100.00**
Average efficiency (%)		49.06		34.58