PRIVATE CAPITAL FORMATION IN INDIAN AGRICULTURE: AN ANALYSIS OF FARM LEVEL DATA

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1. ABOUT THE STUDY:

A brief statement of the imperatives for agricultural growth – development, and the context, complexity and concerns of Indian agriculture would provide a required backdrop for this study (Bisaliah, 2009.a and 2009.c), and a basis for identifying drivers and directions of agricultural growth.

The major imperatives for placing agriculture on the top of development agenda are: a large segment of population depending on agriculture for livelihood, positive relationship between agriculture growth and poverty reduction, key to higher GDP growth rate through supply and demand routes, widening and deepening rural - urban development divide, increasing food insecurity and so on. Depletion and degradation of natural resource base, declining share of agriculture (17%) in GDP without any concomitant change in labour force depending on agriculture, falling investment (especially public investment), decelerated productivity/output growth, dominance of small and marginal holdings forming over 80% of total holdings, low productivity of labour engaged in agriculture, technology fatigue, low and declining TFP and high degree of development segmentation/dualism within agriculture sector are some of the major symptoms of concerns and complexity of Indian agriculture. These are also indicative of drivers and directions of growth in the sector. To cite a few broad trends in support of this, growth rates of per capita productivity of land, labour and capital have declined between 1980/81 - 1990/91 and 1990/91 - 1998/99. Further, trend growth rates in fixed capital stock, technology, gross irrigated area, electricity use and cropping intensity in agriculture have decelerated between 1980s and 1996-97/2003-04. Due to all these developments, the growth performance of Indian agriculture has been far from satisfactory. There has been deceleration in the growth rate of AGDP from 3.5% per annum during 1981-82 to 1996-97 to
around 2% during 1997-98 to 2004-05. These developments have adversely affected the rural sector, where over 70% of the poor in India are ‘parked’. As a result, India continues to be the home of largest number of poor and hungry people, the ‘solution’ to which is the major determinant of realisation of Global Millennium Development Goal.

The experiences and evidences on growth, poverty reduction and livelihood security are indicative of some ‘tested’ development policies, programmes and approaches (Bisaliah 2010).

First, poverty responds more to inclusive rural growth than urban growth, leading to the inference that high GDP growth is only a necessary condition for poverty alleviation; what matters is the pattern of growth, the very origin of GDP. In fact service sector-led GDP growth and decelerated growth in agriculture have led to slowdown in poverty reduction. Countries that have experienced reduction in poverty are mainly characterized by growth of rural sector.

Second, development policies for augmenting productivity of land, labour and capital are crucial for sustainable livelihood security of the rural poor. Hence growth of agriculture sector is critical for enabling the poor to ‘command’ basic goods and services, in addition to food security.

Third, a critical stage has been reached in our understanding of development theory and policy that development/growth-mediated approaches for poverty alleviation are better than safety net approaches, even though short-run palliative safety net measures may be inevitable. In fact, the palliative policies and programmes designed to address the human tragedy (poverty) through social net do not appear to have provided lasting solution.

Fourth, capitalization of agriculture (i.e capital deepening to provide more capital to work with for labour engaged in agriculture) in some countries of Asia and Africa is quite essential for increasing productivity
of land and labour, and thereby to address the problems of poverty and
hunger. In fact, at the global level the nexus between Agriculture
Capital Stock (ACS), agriculture growth, and prevalence of poverty and
hunger have been documented and analysed with macro level data
(FAO 1999 and 2001; Stephan et al 2009; Schmidhuber et at 2009).

Fifth, with respect to studies on Indian agriculture (Bisaliah 2004,
2009.a, and 2010) the positive associations between capital formation
and agriculture growth and agriculture growth and poverty reduction
have been very well validated.

Sixth, the concept of investment to augment productive capacity of
agriculture entails not merely investment in physical assets, but
investment in human capital, science and technology, social capital
build up and in infrastructure is quite essential. Further public
investment in/for agriculture has a large component of public good and
this kind of investment has ‘inducement’ effect on private investment –
both at farm household level and corporate sector.

With respect to studies on ACS and the impact of ACS on agriculture
productivity/output growth, and poverty alleviation, almost all the
studies have been conducted with macro level data. For example,
studies by FAO (1999 and 2001), Stephan et al (2009), and
Schmidhuber et al (2009) are all global studies, focusing on broad
groups of global regions. The recently developed data set by FAO on
ACS from 1975 to 2007 is a good attempt to provide Country-wise data
on ACS, comprising of four components of ACS viz land, livestock,
machinery and structure. But it does not differentiate between public
and private sector investment – farm household and corporate sector
investment. This classification is quite essential for defining proper
policy structure to influence capital formation in/for agriculture. Further,
two approaches are used in FAO studies to measure ACS (Stephan et al
2009) one based on National Accounts Estimates (for some countries),
and the other based on physical inventories contained in the FAOSTAT
database. In fact, the strengths and weaknesses of these approaches
have been recognized, and the need for refining and reconciling estimates of ACS, including upstream and downstream sectors and rural infrastructure in developing countries, is suggested. With all these refinements and reconciliation, the limitation still persists due to lack of classification of ACS into public and private sector investment, without which policy and programme designs to influence public and private investment in/for agriculture are difficult. For example, the determinants of public and private investment and between farm household and corporate sector investment need to be identified for effective and appropriate policy making for influencing ACS.

As regards capital formation in agriculture in India, about 76% is from private sector (with farm household investment forming over 70%) and 24% from public sector. This establishes the need for studies on temporal, spatial and farm-size-wise capital formation for identifying policy options to influence farm level capital formation. However, there are hardly studies conducted on this theme. In view of this, the Policy and Programme Support Division (TCS) of FAO has initiated the present study on India to analyse various aspects of farm level capital formation.

The specific objectives of the study are to:

- Investigate the trends in growth of capital stock at farm level.
- Analyse shifts in composition of capital stock.
- Examine trends in capital intensity and productivity ratios.
- Establish the relative importance of ACS vis-à-vis other factors in explaining variations in agricultural output.
- Examine the determinants of productivity of labour engaged in agriculture.
- Analyse factors governing capital formation at farm level.
- Provide an empirical basis for policy/programme designs so as to create an enabling environment to support farm level capital formation.
The database and analytical methods proposed to be used for addressing the objectives of the study will be discussed under Section 4.

2. CAPITAL FORMATION, GROWTH AND POVERTY: CROSS COUNTRY EXPERIENCES

A brief reference to cross-Country growth experiences (Bisaliah, 2010) and the link between agricultural growth and poverty would provide a basic backdrop for the present study. The major inferences and lessons from the cross Country studies are detailed as below:

First, a search for sources of growth through growth accounting both in theoretical and empirical studies has validated the argument that capital (a broad concept consisting of physical, human, institutional capital and so on) is one of the critical factors for growth. In all three major growth theories - Classical, Neo - Classical and Endogenous - the role of capital has turned out to be critical for growth, even though different versions of growth theory have placed emphasis on various forms of capital.

Second, growth accounting studies through growth regressions have drawn the inference that capital is critical for ‘catch up’ in growth path and for growth convergence. Any failure to ‘catch up’ through capital accumulation and technological advancement (for which investment is needed) would lead to persistence of divergence in labour productivity, TFP and growth across countries. In fact, cross Country growth accounting studies have identified physical and human capital, investment in R & D, macro-economic management and social infrastructure (referring to institutions and policies) as deep drivers of growth.

Third, the growth accounting regression study (Senhadji, 2000) across broad groups (like Latin America, Sub-Saharan Africa and South Asia)
of developing countries has again validated the dominant role of physical capital vis-à-vis other drivers of growth (like labour, human capital and TFP). Capital deepening (giving each worker more capital to work with) would make a substantial difference to productivity and output growth. Further, capital accumulation is justified as an escape from the ‘vicious circle of poverty’.

**Fourth,** the debate on the nexus between growth and poverty is even though inconclusive is suggestive of the widely endorsed inference that growth generally does not trickle down automatically to the poor. There can be growth without development. Hence inadequacy of growth alone for poverty reduction is recognized and choice of sectors (called pro-poor-growth sectors) and the ‘growth plus intervention’ are to be put in place.

2.1 Since poverty is dominantly a rural phenomenon (Bisaliah, 2009.b for details), the imperative for reinstating agricultural/rural sector at the centre of development agenda of developing countries has been conceded. There are certain basic reasons why and how growth of rural sector could lead to poverty reduction, along with contributing and supporting growth maximisation.

**First,** high growth performance of agricultural sector tends to trigger rural non-farm activities which could lower rural unemployment and underemployment and poverty through development multiplier effect.

**Second,** the study by ESCAP (2008) has led to the inference that decelerated growth has undermined the capacity of ESCAP region to reduce poverty and inequalities which are the major development policy goals.

**Third,** the rate of poverty reduction depends mainly on growth pattern and the sectoral composition of aggregate output growth which would contribute for a higher rate of poverty reduction (Ravallion, 2000 and 2002). Hence growth efforts are to be directed to areas where the poor people live, sectors in which poor people work, to the factors of
production they possess and to the products they consume. Because majority of the poor live and work in rural areas, have little education, provide unskilled labour and consume mostly basic necessities such as food, emphasis on agricultural/rural growth becomes the nodal strategy.

2.1.1 What do the cross-Country studies suggest about the agricultural growth and poverty reduction? (Details in Bisaliah, 2010). A few inferences on this issue could be stated.

First, cross Country agricultural growth and poverty suggest the closer link between decelerated agricultural output/productivity growth and slowdown in poverty reduction. The development experience of China suggests that growth in TFP in agriculture and high level of productivity of labour engaged in agriculture are both crucial for poverty reduction (Majid, 2004). On the other hand, Sub-Saharan Africa has registered worst growth performance in both agricultural labour productivity and TFP in agriculture, leading to high density of poverty.

Second, a comprehensive cross Country study by Prasad et al (2004) has drawn the inference that agricultural productivity variable and thereby TFP, among others, exert a significant ameliorating influence on incidence of poverty. Further TFP in agriculture is identified as one of the dominant sources of productivity growth, suggesting the need for adequate investment in maintaining a high rate of growth in TFP.

Third, to make agriculture socially and economically viable and to promote inclusive growth (Dev, 2008), adequate capital investment is needed for developing human capital, augmenting R&D capacity, irrigation and water management, development of rural growth centres so as to provide non-farm income and employment opportunities, and for rural infrastructure such as electricity and roads (Fan et al 2002 and Mccullock et al 2007). Hence capital formation is
suggested as a major driver of agricultural productivity/growth and poverty reduction.

**Fourth**, it is recalled from Section 1 that studies (FAO 2001 Stephan, et al 2009 and Schmidhuber et al 2009) have brought out clearly the relationship between ACS, productivity of labour and hunger in developing countries. These results (Bisaliah, 2010) validate the theorem that ACS tends to have positive impact on productivity of labour engaged in agriculture, and thereby negative impact on prevalence of hunger in developing countries. This is suggestive of the agricultural development policy that lays emphasis on capital deepening in agriculture.

**Fifth**, a few broad conclusions of study by Stephan et al (2009) on developing countries, as related to trends in ACS and the role of government expenditure on agriculture to influence ACS are relevant.

- At the global level, ACS has been growing almost at declining rates. The growth rate was only 0.5% during 1991 – 2007.
- The growth rate of ACS is the least in countries with highest prevalence and depth of hunger.
- Government expenditure on agriculture is positively correlated with capital formation in a sample of developing countries and government expenditure on agriculture has significant positive impact on TFP.
- Capital/Labour ratios in agriculture are falling in countries with the highest prevalence and depth of hunger.

3. **MACRO EVIDENCES ON CAPITAL FORMATION IN/FOR AGRICULTURE, GROWTH AND POVERTY IN INDIA**

This section is based mainly on three macro level studies (Bisaliah, 2004, 2009.a and 2010). The major evidences and development experiences are abstracted from these studies as related to trends in
and composition of capital formation, complementarity between public and private investment, determinants of investment in agriculture and the impact of investment on agricultural growth and poverty.

First, the investment growth cycle identified for Indian agriculture encompasses rising trend during 1960s, relatively subdued phase during 1970s, momentum of peak during the second half of 1980s, decline thereafter, but marginal recovery during recent years.

Second, there has been a loss of momentum in capital formation in agriculture some time in 1980s as well as 1990s with implications for agriculture growth and poverty reduction. Capital formation in agriculture as a proportion of total GDP and as a proportion of total capital formation in the economy had experienced deceleration. This has been mainly due to fall in public investment.

Third, many of the problems of Indian agriculture sector viz low productivity, low employment opportunities, high intensity of poverty and inadequate infrastructure are attributed to inadequate and progressive decline in capital formation (Thorat et al 2003 and Mujumdar, 2006) especially public investment in physical capital (irrigation, rural electrification, roads, markets and so on) and development of non-farm sector. The infrastructure support will have to be provided through public sector investment. In fact, the level of public investment is crucial for growth of agricultural output and for addressing other development policy goals like unemployment and poverty (Blarcom et al 1993 and Alagh, 1997). It is established that growth in farm output has slowed down since the early 1990s, mainly due to inadequate infrastructure, among others (Thorat et al 2003).

Fourth, even though there has been a fall in public investment, there has been some increase in private investment. But private investment cannot be treated as a substitute for public investment, since the composition of private and public investment are different. Public investment is mainly in medium and major irrigation works, in addition
to investment in other types of rural infrastructure, while private investment is mainly in minor irrigation, machinery and land development. Apart from difference in composition, public investment affects directly growth performance of agriculture, indirectly its inducement effect on private sector investment. Added to this, there appears to be more evidence to confirm the hypothesis on complementarity between public and private investment, without ignoring other determinants of private capital formation.

Fifth, in addition to downward shift in capital formation in agriculture (even with some marginal recovery during recent years), compositional shift as between public and private sector in total investment has taken place. The percentage share of public sector in total investment had declined from 43% in 1960 to 24% in 2005/06, while private sector investment had increased from 57% to 76% during the same period. As argued in the preceding para, they can not be treated as substitutes.

Sixth, as discussed under Section 1, during 1980s and 1996/97 – 2005/06, the Country is found to have experienced fall on growth rates of net fixed capital in agriculture, stagnation in technology development, fall in growth rates of irrigated area, negative growth rate in electricity use in agriculture and fall in growth rate of cropping intensity. All these proximate drivers of agricultural productivity/production growth would tend to give rise to decelerated growth in Indian agriculture growth and to mobilize the ‘support’ of these drivers more investment in agricultural sector is needed.

Seventh, there is a difference in the investment behaviour of public and private sector. Public investment is determined mainly by political economy compulsions, while private investment is found to be positively impacted by public investment (through inducement effect), terms of trade, technology and institutional credit and negatively impacted by the incidence of rural poverty and percentage area under marginal holdings. Policy implications of these and the needed policy directions will be discussed later.
Eighth, apart from methological complexities (Bisaliah, 2010) the positive and significant impact of investment in agriculture on productivity/output has been empirically established. In a multivariate framework, the impact of investment, rural literacy, terms of trade, institutional credit, cropping intensity (a proxy for the impact of irrigation and technology) and rainfall on AGDP are found to be positive. Further, the relationship between agriculture productivity and infrastructural variables like transport, power, irrigation and research is found to be quite strong.

Ninth, Rural Poverty Function has been estimated by Roy (2001), in a simultaneous equation framework. Private investment, rural literacy, village electrification, terms of trade, rural roads and credit flow to rural sector are found to have positive impact on poverty reduction, whereas population has negative impact on poverty reduction. Investment in agriculture helps to reduce poverty directly and indirectly through agriculture growth, by improving employment and wages in rural sector and by reducing the prices of stable food items (Thorat et al 2003). In this study, public investment is found not to have impact on poverty; but public investment has positive impact on agricultural productivity, which in turn contributes for poverty reduction through employment and wage effects. Hence, investment affects positively rural poverty directly and indirectly.

A brief exposition of macro level evidences and experiences related to trends in investment in Indian agriculture, compositional shifts in these investments, determinants of investment and the impact of investment on productivity/output in the sector and on poverty will be used later for identifying the pathways and policy options for influencing capital formation at farm level.

4. DEVELOPMENT OF DATA SET AND ANALYTICAL TOOLS:

Given the objectives set out for the study, farm level data are required. The Directorate of Economics and Statistics (DES), Ministry of
Agriculture, Government of India, has instituted a scheme called “Comprehensive Cost of Cultivation Scheme” (CCCS), under which farm level data are collected by Agricultural Universities and other Research Institutions spread across the Country. Data are collected on all Principal Crops for different seasons and years by field level technical staff of DES from over 8000 sample farmers spread across the agro-climatic regions of the Country. The collection of data is through 39 schedules (or record types) following cost accounting method. Depending on nature of data, the field level technical staff of the CCCS collects data from sample farmers on daily, monthly or yearly basis. The results on cost of cultivation derived from data, are provided to Commission on Agricultural Costs and Prices (CACP), Government of India so as to facilitate recommendations on Minimum Support Prices (MSPs) on all Principal Crops. These recommendations are the basis for Government of India to announce MSPs for crops during two major seasons.

4.1 For the present study two data sets have been developed. The first data set is aggregative in nature in the sense that it consists of values of capital assets such as land capital, animal capital, irrigation capital and farm machinery, and data are drawn from the general data pool of DES, collected from 15 States for the years 1994-95 and 2007-08. Since the values of these four types of capital assets are in present values, they are deflated into values at constant prices with deflators developed by Central Statistical Organisation (CSO) with 1999-2000 as the base.

4.1.1 Given the nature of the data accessible in aggregative form, three ratios have been computed:

- Animal Capital/Farm Machinery Ratio (AC/FM)
- Farm Machinery/Irrigation Capital Ratio (FM/IC)
- Animal Capital/Irrigation Capital Ratio (AC/IC).

- Growth Rates of AC, FM and IC have been computed.
- Compositional shifts have been analysed in two ways:
∗ Percentage value share of land, AC, FM and IC in total capital stock.

∗ Percentage value share of non-land capital assets viz AC, FM and IC in the total of non-land capital assets.

The ratio, growth rate and compositional shift analyses have been done for two periods of time viz 1994-95 and 2007-08, forming a total of 13 years adequate enough to identify temporal shifts.

4.2 The second data set on farm households have been developed, drawing data from the general data pool of DES. In the present study, three States based on the criterion of productivity of land have been sampled – High Productivity State (Punjab), Medium Productivity State (Andhra Pradesh) and Low Productivity State (Orissa). From each one of these three sample States, 50% of the samples of DES study for the years 1994-95 and 2007-08 have been selected at random, the randomness being every alternative sample from each Tehsil. The sample structure of the present study is as below:

**Table 4.1: Sample Structure**

<table>
<thead>
<tr>
<th>State</th>
<th>Number of Tehsils</th>
<th>Year</th>
<th>Total DES Sample</th>
<th>Total Sample for the Present Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Punjab</td>
<td>30</td>
<td>1994 - 95</td>
<td>300</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>2007 - 08</td>
<td>300</td>
<td>150</td>
</tr>
<tr>
<td>2. Andhra Pradesh</td>
<td>60</td>
<td>1994 - 95</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>60</td>
<td>2007 - 08</td>
<td>600</td>
<td>300</td>
</tr>
<tr>
<td>3. Orissa</td>
<td>45</td>
<td>1994 - 95</td>
<td>450</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>2007 - 08</td>
<td>450</td>
<td>225</td>
</tr>
<tr>
<td><strong>Total Sample for Two Years</strong></td>
<td><strong>2700</strong></td>
<td></td>
<td><strong>1350</strong></td>
<td></td>
</tr>
</tbody>
</table>
It could be seen that the data set developed for this study consists of 1350 sample farm households of three sample States for 2 years. Data from these 1350 sample farm households on educational level of the respondent, operated land holding (both area and value), area under irrigation, values of AC, FM and IC, total labour (both family and hired) employed for farm operations, gross value of output and credit facility availed have been drawn from the general data pool of DES, depending on accessibility. Since the values of land, animal capital, farm machinery and irrigation capital are in present values of the years 1994-95 and 2007-08, they have been deflated into values at constant prices by using the deflators developed by CSO with 1999-2000 as the base.

It is realized that tree capital stock would form an important item of ACS, and its importance varies with the growth stage of the economy (Larson et al 2000). In view of data constraint, tree capital as an item of farm level ACS could not be considered. Again due to data constraint, farm building structures for animals, agricultural implements and machinery also could not be considered. Nor any attempt is made in this study to estimate the value of farm building structures as a function of animals and agricultural implements and machinery as done in the study by Stephan et al (2009). Yet another methodological issue that needs to be considered is whether the value of the land should be treated as an item of capital stock, along with AC, FM and IC. In most of the studies, value of investment made for land improvement is considered. In this study, value of land is also considered as a item of capital stock, because its inclusion in capital stock would provide insights into how important is land capital stock vis-à-vis other items of capital stock in case of farmers in India.

4.2.1 Given the nature of data and items on which data are accessible, the next step is to decide on the tools for analyzing the farm level data of three sample states. The choice of tools, obviously, depends on the objective structure of the study.
4.2.2 Compound Growth Rates between 1994/95 and 2007/08:

- Growth Rates of four items of Capital Stock:
  - Land (measured in hectare)
  - A.C: Measured in ``, and deflated
  - F.M: Measured in ``, and deflated
  - I.M: Measured in ``, and deflated.

- Growth Rates are estimated for the aggregative data of all the three States, State-wise and farm-size-wise.

4.2.3 Shifts in Composition of Capital Stock between 1994-95 and 2007-08:

- Aggregative Compositional Shifts: All the three States and all the farm-size groups
  - The percentage share of land, AC, FM and IC in the total value of all the four capital assets (K):
    - Land/K, AC/K, FM/K, IC/K
  - The percentage share of AC, FM and IC in the total value of all the three non-land capital assets (C):
    - AC/C, FM/C, IC/C

- Disaggregative Compositional Shifts: The percentage shares in both K and C are computed for individual States and for three farm size groups.

The rationale for considering land as one of the capital assets has been stated under Section 4.2. The rationale for considering non-land capital assets as a group is quite obvious.

4.2.4 Factor – Intensity and Factor – Productivity: Ratio Analysis for Two Periods
Land (A) measured in hectare and value measures (`) are employed in case of AC, FM, IC, total of non-land capital assets (C) and in case of Gross Value of Output (GVO), and Labour (L) measured in physical units Mandays. Data from National Accounts on GDP from agriculture (GDPA) in current prices and GDPA at constant prices (2004-05 base) are used for deriving the deflator for making adjustments to GVO data used in the present study.

**Factor – Intensity Measures:**

- Land – Capital Intensity: \( \frac{C}{A} \)
- Land – (FM+IC) Intensity: \( \frac{FM+IC}{A} \)
- Labour – Capital Intensity: \( \frac{C}{L} \)
- Labour – (FM+IC) Intensity: \( \frac{FM+IC}{L} \)
- Land – Labour Intensity: \( \frac{L}{A} \)

**Factor Productivity Measures:**

- Labour – Output Ratio: \( \frac{GVO}{L} \)
- Non-Land Capital – Output Ratio: \( \frac{GVO}{C} \)
- Land – Output Ratio: \( \frac{GVO}{A} \)

The factor – intensity and factor – productivity analysis for two periods of time (1994-95 vs 2007-08) would provide insights into changing capital intensity and productivity of Labour, Capital and Land. It is realized these measures are partial intensity and partial productivity measures.

The factor – intensity and productivity analysis is performed with pooled data of all three sample States and pooled data of all farm size groups (aggregative analysis) and with data for individual States and different farm size groups (disaggregative analysis).

### 4.2.5 REGRESSION MODELS:

The main objective of the proposed regression models is to answer three questions relevant to the present study. How important is
capital vis-à-vis other factors in influencing gross value of output (GVO) at farm level? Second, since productivity of labour engaged in agriculture has direct bearing on prevalence of hunger and poverty, what factors would explain the variations in productivity of labour at the farm level, and what is the relative importance of capital stock vis-à-vis other factors in influencing productivity of labour? Third, what are the major determinants of capital formation at farm level? Following all these what path ways and policy interventions could be derived from the analysis with regression models and other empirical evidences available on capital formation, agricultural growth and poverty alleviation?

To address the issues lined up above, three basic regression, models are proposed viz GVO function, labour productivity function, and capital formation function. It needs to be stated that the choice of variables as well as their measurement depends on the accessibility to farm level data.

Before the formulation of proposed three regression models, the definition and measurement of dependent and independent variables used in the present study for both aggregative and disaggregative analysis are discussed.

- **GVO** = Gross value of farm level output, measured in `, and deflated using data on AGDP at current and constant prices reported in National Income Accounts of Central Statistical Organisation (CSO).
- **AC** = Value of animal capital measured in `, and deflated using the deflator developed by CSO.
- **FM** = Value of farm machinery measured in `, and deflated using the deflator developed by CSO.
- **IC** = Value of irrigation capital measured in `, and deflated using the deflator developed by CSO.
● NLC = Non-land capital (AC+FM+IC) measured in `, and deflated using the deflator developed by CSO.

● A = Area of land measured in hectare.

● L = Labour (total of both family and hired/casual labour) measured in physical units of man days.

● DVL = Literacy status expressed in the form of dummy variable (DVL) with a value of 1 if the farmer is literate and zero otherwise.

● DVCR = Credit status expressed in the form of dummy variable (DVCR) with a value of 1 if credit availed by the farmer and zero otherwise.

● DVY = Year dummy variable (DVY) with a value of 1 for 2007-08, and 1994-95 is the base with a value of zero.

● DVS\(_1\) = State dummy variable (DVS\(_1\)) with a value of 1 for Andhra Pradesh and zero for Punjab, where the data of these two States are pooled.

● DVS\(_2\) = State dummy variables (DVS\(_2\)) for the pooled data analysis of all the three States.

● GVO/L = GVO per physical unit of labour (i.e productivity of labour). GVO and L as defined and measured earlier.

● AC/A = Value of animal capital per hectare measured in `.  

● FM/A = Value of farm machinery per hectare, measured in `.  

● DVIR = Irrigation dummy variable (DVIR) with a value of 1 for presence of irrigation and zero otherwise.

With these definitions, three regression functions can be specified. All these regression functions are specified in log form and relevant elasticities are derived from the estimated functions.

4.2.5.A GVO Regression Function:
Depending on availability/accessibility to farm level data, the major determinants of GVO identified are: Animal Capital (AC), Farm Machinery (FM), Land Area (A), Irrigation (DVIR), Literacy (DVL), Credit Availment (DVCR) and year effect and regional effect/State effect, to be captured through dummy variables. Given these determinants, a complete GVO function in logarithmic form (Ln) is specified as follows:

\[
\text{Ln GVO} = A + a_1 \text{LnAC} + a_2 \text{LnFM} + a_3 \text{LnA} \\
+ a_4 \text{DVIR} + a_5 \text{DVL} + a_6 \text{DVCR} \\
+ a_7 \text{DVY} + a_8 \text{DVS}_1 + u \quad \ldots \ldots \text{(1)}
\]

Where: A is the constant term, \( a_\text{s} \) are the regression coefficients/GVO elasticities, and \( u \) is the random error term.

### 4.2.5.B Labour Productivity Function:

The major determinants of labour productivity at farm level are postulated to be: animal capital per hectare of land (AC/A), farm machinery per hectare of land (FM/A), irrigation (DVIR), literacy (DVL), credit availment (DVCR), and year effect (DVY) and regional/State effects (DV\( S_1/DV\text{S}_2 \)). A complete model of labour productivity is specified as detailed below:

\[
\text{Ln (GVO/L)} = B + b_1 \text{Ln}\frac{AC}{A} + b_2 \text{Ln}\frac{FM}{A} + b_3 \text{DVIR} + b_4 \text{DVL} + b_5 \text{DVCR} + b_6 \text{DVY} + b_7 \text{DVS} + u \quad \ldots \ldots \text{(2)}
\]

Where: B is the constant term, \( b_\text{s} \) are regression coefficients/elasticities and \( u \) is the random error term.

### 4.2.5.C Capital Formation Function:

This section is concerned with formulation of a capital formation model, where in the determinants of non-land capital stock (NLC) are specified.

\[
\text{LnNLC} = C + C_1 \text{LnA} + C_2 \text{DVCR} + C_3 \text{DVL} + C_4 \text{DVY} + C_5 \text{DVS} + u \quad \ldots \ldots \text{(3)}
\]
Where: \( C \) is the constant term, \( C_s \) are regression coefficients/elasticities and \( u \) is the random error term.

It is realized that terms of trade and technology are other important determinants of capital formation at farm level. In the absence of data on technological status of individual farms and almost the same value of terms of trade for all the farmers, these two variables could not be incorporated into the farm level capital formation function. However, the importance of these two variables in determining private capital formation will be discussed under Section 10 (Substantive Inferences, Conclusions and Policy Directions) of this study, drawing results from State level studies on private capital formation documented in (Bisaliah, 2004 and 2010).

5. TRENDS IN GROWTH RATES, RATIOS AND COMPOSITION OF CAPITAL STOCK: POOLED DATA ANALYSIS OF FIFTEEN STATES

Given the objectives set out for this study and farm level pooled data for all the fifteen States for two years viz 1994-95 and 2007-08 (forming a period of 13 years), analysis is made in this section on trends in growth rates of non-land capital assets, non-land capital ratios and shifting composition of capital assets.

5.1 Growth Rate Analysis:

It is observed from Table 5.1 and the associated figure that the growth rate of non-land capital assets between 1994-95 and 2007-08 was 0.72\%. With respect to capital components, the animal capital growth rate was negative (-1.4), where as the highest growth rate (1.93\%) was in farm machinery followed by growth rate (1.16\%) of irrigation capital. In aggregative terms, there appears to be trend towards the use of labour and animal power substitutes viz mechanical power. Perhaps, this is in accordance with the growth trends in the agriculture sector of developed countries, even though a long term time series
data is needed to be conclusive about this trend. For example the percentage share of implements and machinery in total capital stock increased from 4% between 1870 and 1910, and to 37% between 1910 and 1950 in U.S.A. This trend was because of acute shortage of labour for agriculture and farmers added to their stocks of machinery at an unprecedent rate (Tostelbe, 1957).

5.2 Shifts in Composition of Capital Stock:

An analysis of composition of total capital stock (Table 5.2 and the associated figure) suggests that land is found to be the dominant component of capital stock, forming 94% of total capital in 1994-95 and land asset increased its share by 1% point by 2007-08. In 1994-95, all three non-land capital assets formed 2% share each and by 2007-08 the percentage shares of both farm machinery and irrigation machinery remained constant whereas animal capital experienced 1% fall in its share by 2007-08.

Two inferences could be drawn from these trends. First, land is still the dominant capital stock to average sample Indian farmer and the share of non-land capital assets is quite small vis-à-vis land capital, suggesting the need for more of non-land capital assets. Second, the historical study (Tostelbe, 1957) of composition of capital stock in American agriculture between 1870 and 1950 has drawn the inference on declining importance of land on a considerable scale and on increasing importance of implements and machinery. This second inference, however, is not meant to disregard the difference in the methodology of measurement of capital components and the analysis.

Shifts in composition of non-land capital assets would yet form another way of capital component analysis (Table 5.3 and the associated figure). The temporal shift analysis between 1994-95 and 2007-08 suggests the declining share of animal capital and increasing share of both farm machinery and irrigation capital. However, the percentage points of increase was 5% in case of farm machinery and in case of
irrigation capital the percentage points of increase was 2% between 1994-95 and 2007-08. That again establishes a broad trend of increasing importance of farm machinery vis-à-vis other two non-land capital assets.

5.3 Capital Intensity Analysis:

The results on non-land capital intensity analysed in the study are in Table 5.4 and the associated figure. The ratio of AC/FM had declined from 0.94 in 1994-95 to 0.64 in 2007-08 and the same trend was observed in case of AC/IC (ie from 0.92 to 0.66), whereas in case of capital intensity measured in terms of FM/IC, it had increased from 0.95 to 1.04, suggesting the increased importance of farm machinery vis-à-vis irrigation capital. This could be inferred as a changing preference structure of farmers for non-land capital assets, even though the period of study (13 years) may not be that long to be conclusive. However, these results are indicative of trends likely to be registered at the farm level in future.

6. GROWTH RATE, COMPOSITIONAL SHIFT AND RATIO ANALYSIS OF AGRICULTURAL CAPITAL STOCK IN SAMPLE STATES:

It is recalled from Section 4.2, three States viz Punjab, Andhra Pradesh and Orissa have been sampled for the analysis, based on productivity of land. A total of 1350 farm samples have been drawn from the general data pool (Table 4.1) for the years 1994-95 and 2007-08. The results on growth rates, composition of capital stock and various ratios to measure changing capital intensities and productivity of land, labour and capital are analysed both at aggregative level (pooled data of all States and pooled data of all farm households irrespective of the farm size) and at disaggregative level (data of individual States and different farm size groups).

Certain broad inferences could be derived from the results presented in Table 6.1:
First, between 1994/95 and 2007/08, the percentage change in non-land capital stock (animal capital, farm machinery and irrigation capital) was negative in Andhra Pradesh (-35.76%) and in Punjab (-24.3%). There was only a marginal increase in the capital stock in Orissa. The negative change in non-land capital stock in high and medium agricultural productivity performing State is a disturbing trend. Second, the percentage area irrigated is found to establish the needed pathway for irrigation development. The relationship between percentage area irrigated and productivity growth performance are found to be positive. To reinforce this, per hectare productivity of land was over ` 72 thousand in Punjab during 2007-08, whereas it was about ` 29 thousand in Andhra Pradesh, and only about ` 17 thousand in Orissa. Third, per hectare non-land capital stock during 2007-08 in Punjab farms was over ` 45 thousand, whereas it was a little over ` 10 thousand in Andhra Pradesh and a little over ` 4 thousand in Orissa. Fourth, the productivity of labour was the highest in Punjab, followed by Andhra Pradesh and Orissa. Further productivity of labour and non-land capital intensity are quite positively related. Fifth, the percentage of both rural and urban poverty varies inversely with productivity of land and labour. Added to this is the higher density of poverty in rural areas, related very well to productivity of land and labour, and to intensity of non-land capital stock.

It is recalled from the aggregative study by Stephan (et al 2009) that ACS, and productivity of labour engaged in agriculture are positively related, and productivity of labour and prevalence of poverty and hunger are inversely related. The present study validates this theorem on the relationship among these three parameters, using data of three sample States. Figure 1 establishes the negative relationship between capital intensity and rural poverty, Figure 2 also validates the negative relationship between productivity of land and rural poverty, and Figure 3 also conclusively leads to the inference that there is a negative relation between labour productivity and rural poverty. Figure 4 reveals the positive association between capital intensity and productivity of
land, and Figure 5 positive association between capital intensity of labour and productivity of labour. In brief, capital formation in/for agriculture is a critical factor for increasing productivity of land, labour and for reducing poverty.

6.1 Aggregative Analysis: Pooled Data Analysis of Sample States and Farms

An analysis of aggregative growth rates and of growth rates of sample States (Table 6.2) would lead to four major inferences. First, the overall growth rates of all the three non-land capital assets are found to be negative between 1994-95 and 2007-08. A stronger negative growth trend is observed in case of irrigation capital (-6.05%), followed by farm machinery (-4.11%) and animal capital (-0.74). Second, the growth rates of farm machinery and irrigation are also negative in all the three States except positive growth rate of farm machinery in Orissa. High negative growth rates (over 10%) of irrigation capital in Punjab may be indicative of over exploitation of ground water resources. Third, overall negative growth rate of operated land holding (in hectare) was recorded in Punjab with the highest rate of negative growth, followed by Orissa. However in Andhra Pradesh there was a positive growth rate of land capital. Fourth, a little over 2% negative growth rate was recorded in overall of non-land capital assets, with negative growth more in Andhra Pradesh followed by Punjab. The negative growth rate of farm machinery and irrigation capital was a little over 3%, contributed by Andhra Pradesh and Punjab. Some positive growth rate in Orissa could not prevent the overall negative growth rate of farm machinery and irrigation capital in sample States.

6.2 Disaggregative Analysis: State - Wise and Farm Size - Wise

The present section is concerned with addressing two important issues. First, how are the growth rates of four components of total capital stock of three non-land capital components and of two non-land components viz farm machinery and irrigation capital. This issue is addressed with respect to all the three farm-size groups.* Second, how is the growth
rate performance of individual States in case of components of capital stock mentioned above and of different farm-size groups of these States. The results on these issues are in Table 6.3.

6.2.1 Capital Growth Performance of Marginal and Small Forms:

With respect to overall capital growth performance of marginal and small farmers of all the three States, the growth rates of land, animal capital and irrigation capital were found to be negative, with highest negative growth rate (-7.1%) recorded in case of irrigation capital. On the other hand, there was a positive growth rate (2.5%) in case of farm machinery. Yet another way of examining capital stock growth performance of this farm group is to examine the growth rates of all non-land capital assets, and farm machinery and irrigation capital which have a direct bearing on productivity of land. With respect to both, the growth rate was marginally positive (0.32%) in case of all non-land capital assets and positive (1.51%) in case of farm machinery and irrigation capital. But the most disturbing trend in case of marginal and small farms is high negative growth rate (-7.1%) of irrigation capital which is a land substitute (and thereby land augmenting) for these farms.

Large: More than 10 Hectare.

The Capital Growth Performance of Small and marginal Farms in Individual States Suggests that:

(a) In Punjab, there was a negative growth in case of land (-0.34%), animal capital (-2.5%) and irrigation capital (-16.7%). This high level of negative growth rate of irrigation capital is quite disturbing in a State of high land productivity growth performer. Further, the positive growth rate of 5.8% was in case of farm machinery, and in case of all non-land capital assets and farm machinery and irrigation capital grouped together. Hence the positive growth rate of farm machinery had more than offset the
negative growth of irrigation capital. But farm machinery cannot be a substitute for irrigation capital stock.

(b) The small and marginal farms of Andhra Pradesh had experienced negative growth rate in case of irrigation capital and farm machinery, leading to negative growth rates of farm machinery and irrigation capital grouped together, and of all non-land capital assets as well.

(c) In Orissa, there was a positive growth rate of 1.7% of animal capital, and in case of other items of capital, the growth rates were either negative or marginally positive.

6.2.2 Capital Growth Performance of Semi-Medium and Medium Farms:

The overall capital growth performance of three sample States indicates that the growth rates of all capital components were negative, the highest (-5.2%) being in case of irrigation capital. The analysis of capital growth performance of individual States suggests that:

(a) The semi-medium and medium farms of Punjab had recorded negative growth rate in land, animal capital, farm machinery and irrigation capital, with irrigation capital registering highest negative growth rate of -11.3%. There were only marginal positive capital growth rates in case of all non-land capital assets and farm machinery and irrigation capital group.

(b) In Andhra Pradesh, the growth rates of all capital components were negative in these farms. The negative growth rate was the highest in case of farm machinery (-4.8%), followed by the farm machinery and irrigation capital group and by all non-land capital group.

(c) Only in case of farm machinery, high positive growth rate of 6.1% had taken place in Orissa, leading to a positive growth rate 2.87% under farm machinery and irrigation capital group. In case of all
other capital components, the growth rates were marginally, either positive or negative.

6.2.3 Capital Growth Performance of Large Farms:

The overall growth rates of all capital components of large farms were negative, excepting the marginal positive growth rate of land. The highest rate of negative growth had taken place in case of irrigation capital (-6.4%), followed by farm machinery (-3.4%), leading to negative growth rates of two groups of capital stock viz non-land capital stock and farm machinery and irrigation capital. The capital growth performance of individual States is as detailed below:

(a) In Punjab, the growth rates of all capital items/groups were negative as regards large farms. The negative growth rate was the highest (-8.0%) in case of irrigation capital, followed by farm machinery (-3.8%). As a result, the negative growth rates in case of non-land capital group (-1.3%) and of farm machinery and irrigation group (-1.28%) were recorded.

(b) Excepting the positive growth rate (2.49%) in case of operated holding size of large farms in Andhra Pradesh, all other capital assets, individually or as a group, had experienced negative growth rates. The negative growth rates were the highest in irrigation capital (-5.8%), followed by farm machinery (-1.9%) and animal capital (-1.2%), all leading to negative growth rate of non-land capital group (-7.27%) as well as farm machinery/irrigation capital group (-8.44%).

(c) The large farms of Orissa had experienced negative growth rates in case of all capital assets, individually and as a group. The highest negative growth was in case of land (-7.11%). Among non-land capital stock, the highest negative growth rate (-6.8%) was in case of irrigation capital, followed by farm machinery (-2.7%) and animal capital (-1.6%), giving rise to negative growth
rates of non-land capital group as well as farm machinery and irrigation capital group.

7. **SHIFTS IN COMPOSITION OF CAPITAL STOCK BETWEEN 1994-95 AND 2007-08 IN SAMPLE STATES**

Temporal and spatial analysis of trends is composition of four components of total capital stock and three components of non-land capital stock is the basic focus of this section. Further, the analysis is performed with respect to ‘overall’ situation as well as with respect to capital stock composition in sample states separately (Table 7.1).

7.1 The overall results on composition of total stock suggest that the percentage share (94%) of land capital assets was dominant during the first period (P.I) and the share dominance continued during the second period (P.II) also (95%). There was no change in percentage share (2%) of animal capital as well as irrigation capital (1%) during the period of thirteen years, with farm machinery experiencing fall in its share by 1% during the same period of thirteen years.

The capital composition analysis of non-land capital assets reveals that: (a) there was a fall in the share of farm machinery from 48% to 43% during the period and of irrigation capital from 22% to 15% (b) whereas animal capital had increased its share from 30% to 42%. It was the share irrigation capital which experienced a greater decline.

7.2 The State-wise results suggest that:

(a) In Punjab, share of land capital in total capital stock increased from 95% to 96%, whereas the share of animal capital and irrigation capital remained at 1% during P.I and P.II, and the share of farm machinery had declined by 1%. With respect to non-land capital assets, the share of farm machinery was close to two-thirds of the
total value. The share of animal capital had increased from 23% during P.I to 31% during P.II, whereas the share of irrigation capital had drastically declined from 14% to 5%.

(b) In Andhra Pradesh, the share of land in total capital stock had increased from 91% to 97% during two period of time, whereas the percentage share of all other three capital components had declined. With regard to changing composition of non-land capital assets, animal capital had increased its share from 32% to 39%, whereas the other two assets had experienced a fall in their share and the fall in share was higher in case of irrigation capital.

(c) In respect of Orissa, the percentage share of land capital asset in total was quite dominant during both the period, whereas animal capital stock experienced marginal decline, with farm machinery maintaining its share at 2% during both the periods. Among non-land capital assets, animal capital stock experienced decline in its share, whereas farm machinery increased its share by 5%.

7.3 Disaggregative Analysis of Compositional Shifts: Farm Size-Wise Analysis:

This section is concerned with addressing two important issues. First, what was the direction and magnitude of overall capital composition shift in three farm groups during two periods of time. Second, whether there was any compositional difference and shift among three farm groups of sample States. These issues are addressed with results on total capital assets (Table 7.2) and non-land capital assets (Table 7.3).

7.4 Compositional Structure of Capital in Marginal and Small Farms:

It could be observed from Table 7.2 that the overall capital composition structure in case of marginal and small farms was dominated by land with around 94% during both the periods. The share of animal capital and farm machinery was 2% each during both
the periods, and that of share of irrigation capital increased from 1% to 2%. The results on State-wise composition suggests that:

(a) The share of land in total capital stock was around 96% during both the periods in Punjab, and animal capital accounted for 3% during the first period and 2% during second period. Farm machinery and irrigation capital accounted for very little share in total capital stock.

(b) The marginal and small farms of Andhra Pradesh had registered an increase in the share of land in total capital stock from 89% during first period to 96% during second period and had registered decline in the share of all other three types of capital assets.

(c) In Orissa, the dominant share of land in total capital decreased marginally from 95% during first period to 94% during second period. Animal capital had retained its share at 4% during both the periods, with farm machinery experiencing a marginal increase.

7.5 Compositional Structure of Capital in Semi-Medium and Medium Farms:

The overall composition of capital structure again establishes the dominant share of land at 95% during first period and 96% during second period, with animal capital and irrigation capital maintaining their share at 1% each during both the periods and farm machinery experiencing a fall in its share from 3% to 2%. The shifts in the composition of capital structure of semi-medium and medium farms of sample states areas follows:

(a) The share of land in Punjab State had increased from 95% to 97%, and that of farm machinery had declined from 3% to 2%, with animal capital maintaining its share at 1% during both the periods.

(b) In Andhra Pradesh also the share of land had increased from 92% to 97%, and the percentage share of other three types of capital
assets had declined during second period. The decline was much more in case of farm machinery and irrigation capital.

(c) The share of land in Orissa had remained at 96% during both the periods. Animal capital had experienced a marginal decline in its share, whereas farm machinery experienced a marginal increase in its share.

7.6 Compositional Structure of Capital in Large Farms:

In overall, land increased its share in total capital stock from 95% to 97%, and farm machinery experienced a fall in its share from 3% to 2%, with irrigation capital maintaining its share at 1% during both the periods. A state wise analysis of results on shifts in composition of capital suggests as follows:

(a) In Punjab, land had increased its share from 94% to 97%, and in case of farm machinery there was a decline in the share from 4% to 2%, with animal capital retaining its share at 1% during both the periods.

(b) The large farms of Andhra Pradesh had increased their share of land in total capital stock from 89% to 98%, as in the case of other two farm size groups. Drastic decline in the share of irrigation capital from 5% to 1% and marginal fall in the share of animal capital would constitute yet another important feature of shifts in capital composition during the two periods.

(c) The share of land in the total capital stock of Orissa had remained at 91% during both the periods, with animal capital experiencing a marginal fall and farm machinery experiencing a marginal increase in their share.

7.7 The results on the shifts in composition of non-land capital assets are presented in Table 7.3. In this section also two issues are addressed. First, what kind of overall compositional shift had taken place in all the
three farm groups? Second, whether these compositional shifts were different in three farm groups of three States.

7.7.1 Compositional Shifts in Non-Land Capital Assets of Marginal and Small Farms:

In general, ignoring the differences in the compositional shifts in individual States, marginal and small farms are found to have experienced a fall in the share of animal capital from 45% to 30%, and farm machinery from 38% to 31%. On the other hand, the share of irrigation capital had increased from 17% to 39%. The differences in compositional shifts in individual States are as follows:

(a) In Punjab, the percentage share of animal capital in non-land capital was around two-thirds during both the periods. Farm machinery had increased its share substantially from 12% to 32%, whereas irrigation capital had experienced a substantial fall in its share from 21% to 3%.

(b) In Andhra Pradesh, the marginal and small farms had recorded 46% share of animal capital during both the periods, with an increase in the share of farm machinery from 15% to 24%, and decrease in the share of irrigation capital from 39% to 30%.

(c) Animal capital of marginal and small farms of Orissa had recorded a share of 77% in first period and a marginal decline to 75% during second period. There was only a marginal improvement in the share of farm machinery, with insignificant share of irrigation capital.

7.7.2 Compositional Shifts in Non-Land Capital Assets of Semi-Medium and Medium Farms:

The overall share of animal capital had remained constant at 22% during both the periods. Whereas farm machinery experienced
decline in its share from 65% to 48%, and there was substantial increase in the share of irrigation capital from 13% to 30%. The inter-state differences in compositional shifts of non-land capital assets are as detailed below:

(a) In semi-medium and medium farms of Punjab, there was an increase in the share of animal capital from 27% to 35%, and in the share of farm machinery from 58% to 61%. But irrigation capital had experienced a drastic fall in its share from 15% to 4%.

(b) In Andhra Pradesh, the share of all the three non-land capital assets was around one-third during first period, whereas during second period there was a fall in the share of farm machinery and irrigation capital, and rise in the share of animal capital.

(c) In Orissa, these farms had registered a decline in the share of animal capital from 67% to 57%, and increase in the share of farm machinery from 32% to 43%. The share of irrigation capital in total was insignificant.

7.7.3 Compositional Shifts in Non-Land Capital Assets of Large Farms:

The overall performance of large farms of sample States is found to be different compared to other two farm groups. These farms had experienced drastic fall in the share of farm machinery from 72% to 47%, and an increase in the share of irrigation capital from 14% to 40%, with the constant share of animal capital during both the periods. The inter-state differences in the capital composition of large farms are as follows:

(a) In Punjab, the share of farm machinery was quite dominant accounting for 72% during first period and 71% during second period. Animal capital had increased its share from 15% to 22%, whereas there was a fall in the share of irrigation capital from 13% to 7%.
(b) In case of large farms of Andhra Pradesh also, there was an increase in the share of animal capital from 22% to 34%, decrease in the share of farm machinery from 25% to 9%, and marginal increase in the share of irrigation capital from 53% to 57%.

(c) In Orissa, the share of farm machinery had increased from 78% to 85%, and the share of animal capital had decreased from 21% to 15%.

The results on growth rate analysis and compositional structure of capital stock at farm level, both in aggregative and disaggregative frame, are meant to derive substantive inferences and conclusions for identifying the pathways and policy directions for farm level capital formation. These substantive inferences and conclusions will be extracted from the preceded detailed analysis under the last section of this study.

8. FACTOR - INTENSITY AND FACTOR - PRODUCTIVITY IN SAMPLE STATES: AGGREGATIVE AND DISAGGREGATIVE ANALYSIS

The present section lines up two issues for discussion. First, whether factor - intensity ratios and factor productivity ratios (Section 4.2.4) varied between 1994 – 95 and 2007 – 08 in overall as well as in sample States? Second, whether the factor - intensity and productivity ratios of three farm groups (in overall as well as State wise) varied between two periods of time?

8.1 Factor - Intensity and Factor - Productivity: Aggregative Analysis

It could be seen from Table 8.1 that:

(a) In overall, both capital stock per hectare and farm machinery + irrigation capital (FM+IC) per hectare had declined during second period (P.II) vis-à-vis P.I. Further, there was a marginal decline in capital per unit of labour also
(b) The ‘behaviour’ of these ratios varied across States. Punjab represents a typology of increasing capital per unit of land and labour. On the other hand, there was a considerable amount of decline in these ratios during P.II in Andhra Pradesh. As against these two contrasting typologies, Orissa presents a typology of marginal changes (either increase or decrease) in these ratios.

8.1.1 Changing factor – productivity ratios are shown in Table 8.1:

(a) In overall, ignoring differences across States, there was an increase in output per unit of labour, per unit of capital, and per unit of land during P.II.

(b) Obviously, change in factor – productivity ratios across States differ. Punjab had registered the pattern of increased output per unit of labour, capital, and land during P.II. In Andhra Pradesh, the pattern was one of increasing output per unit of labour, per unit of capital, and decline in output per hectare. In Orissa, there was a decline in all the three factor – productivity ratios.

8.2 Factor – Intensity Analysis: Farm Size Wise Analysis

The farm – size wise difference as well as the change in factor – intensity ratios in overall and across the States are presented in Table 8.2. The broad inferences are that:

8.2.1 With respect to marginal and small farms, some increase in capital stock per hectare and capital per unit labour had taken place in overall. Fallowing this, labour per hectare had decreased. The State-wise variations are quite evident.

In Punjab, capital stock per hectare and per unit of labour had considerable increased during P.II. On the other hand, capital stock per hectare and per unit of labour had decreased in Andhra Pradesh. In Orissa, the marginal and small farms had experienced some increase in capital stock per hectare as well as per unit of labour during P.II.
8.2.2 In case of semi-medium and medium farms, the overall capital intensity analysis suggests that there was a marginal decline in capital stock per unit area, and marginal increase in capital per unit of labour \((C/L^*)\) and marginal decline in stock of farm machinery irrigation capital group per unit of labour.

In Punjab, there was a considerable increase in the capital stock with respect to land and labour in these farms. On the other hand, in Andhra Pradesh there was a decline in capital stock with respect to land and labour during P.II. In the State of Orissa, these farms had experienced a marginal increase in capital stock per unit of land, and per unit labour. There was a marginal decline in capital stock of per unit of labour \((C/L^*)\), and marginal increase in farm machinery and irrigation capital group per unit of labour.

8.2.3 The overall capital intensity analysis in case of large farms suggests that there was a decline in capital stock per unit of land as well as per unit of labour during P.II.

In Punjab, the same trend of declining capital stock per unit of land and per unit of labour was recorded during P.II. Large farms in Andhra Pradesh experienced a drastic decline in the stock of capital per hectare of land and per unit of labour. On the other hand, in Orissa there was an increase in capital stock per unit of land and per unit of labour during P.II.

8.3 Factor - Productivity: Farm Size - Wise Analysis

Farm size-wise analysis of factor productivity is presented in Table 8.3

(a) The overall results on factor productivity of marginal and small farms suggest that output (GVO) per unit of labour, capital and land had increased during P.II vis-à-vis P.I.

In Punjab as well as in Andhra Pradesh, the same increasing trend is observed. But Orissa represents a declining trend in output per unit of labour, capital and land during P.II. Hence this declining trend in
Orissa has been more than offset by increasing trend in these ratios in other two States, the overall productivity of labour, capital and land had increased during P.II.

(b) The factor – productivity analysis of semi – medium and medium farms indicates that in overall, there was an increase in output per unit of labour, capital and land during P.II. The same trend is found in case of both Punjab and Andhra Pradesh. But in Orissa, there was a marginal decline in these three productivity ratios.

(c) With respect to large farms, in overall there was an increase in output per unit of labour, capital and land during P.II. Large farms of Punjab had also experienced same pattern of productivity growth. But in large farms of Andhra Pradesh, there was a decline in output per unit of labour and land, and increase in output per unit of capital. In the State of Orissa, there was a decline in output per unit of labour, capital and land of large farms.

9. EMPIRICAL RESULTS ON DETERMINANTS OF GROSS VALUE OF OUTPUT, PRODUCTIVITY OF LABOUR AND CAPITAL FORMATION:

This section is concerned with addressing three issues using empirical results. First, what are the determinants of gross value of output (GVO) at farm level? Related to that is the issue what is the relative importance of capital stock vis-à-vis other determinants? Second, what are the determinants of productivity of labour engaged in agriculture? Added to this issue is the relative importance of capital vis-à-vis other determinants? Third, what are the determinants of capital formation (non-land capital assets) at farm level? To answer these issues, three functions viz GVO Function, Labour Productivity Function, and Capital Formation Function have been proposed under Section 4.2.5.A, B and C respectively. These functions have been estimated with aggregated as well as disaggregative data set. The data of both Punjab and Andhra Pradesh have been pooled for estimating aggregative GVO function. In view of data constraint, the data of Orissa have not be pooled.
However, GVO functions have been estimated for each State. The same procedure has been followed in estimating labour productivity function as well as capital formation function. In addition to State-wise functions, further disaggregative farm group-wise estimates are also made, by pooling the data of all marginal and small farms, semi-medium and medium farms, and of all large farms of all the three States. The empirical results are presented in Tables 9.1 to 9.9.


- The results derived with pooled data analysis of Andhra Pradesh and Punjab (Table 9.1) suggest that:
  
  (a) Animal capital, farm machinery, land, labour, literacy, and credit availment all have positive and significant impact on GVO.
  (b) The explanatory power of the estimated model is validated by high Adj. $R^2$ of 71%.

- State-wise elasticities of GVO are presented in Table 9.2

  * With respect to Punjab:
    (a) Animal capital, farm machinery, land, labour and credit availment are found to have positive and significant impact on GVO. The literacy variable, even though insignificant, has positive influence on GVO.
    (b) High Adj. $R^2$ of 90% validates the explanatory power of the estimated model.

  * With respect to Andhra Pradesh:
    (a) Elasticities of output with respect to animal capital, land, labour, literacy and credit availment are all positive and significant. Elasticity of output with respect to farm machinery, although positive, is not significant.
    (b) Adj. $R^2$ of 63% supports the explanatory power of the independent variables included in the model.
With respect to Orissa:

(a) Farm machinery and labour are positive and significant. But regression coefficients of animal capital and literacy, even though negative, are not significant.

(b) Due to ‘inadequacy’ of data, the value of Adj. $R^2$ is low at 43%.

Farm size-wise elasticities of output are shown in Table 9.3:

* In case of Marginal and Small Farms:

(a) Farm machinery, labour and literacy are found to have positive and significant impact on GVO. The regression coefficients of animal capital and land, even though negative, are not significant, and of credit availment, even though insignificant, is positive.

(b) The relative high Adj. $R^2$ of 59% validates the explanatory power of the model estimated.

* In case of Semi-Medium and Medium Farms:

(a) Farm machinery, labour and credit availment are significant and positive. The regression coefficients of animal capital and literacy, even though insignificant, are positive.

(b) The Adj. $R^2$ of 35% is low compared to either of marginal and small farms or of large farms.

* In case of Large Farms:

(a) Farm machinery, land, labour, and literacy are found to have positive and significant impact on GVO. Regression coefficient of animal capital, even though negative is insignificant, and of credit availment, even though positive, is not significant.

(b) Adj. $R^2$ of 83% validates the explanatory power of the model estimated.

9.2 Labour Productivity Function Estimates:

Tables 9.4, 9.5 and 9.6 show the results on regression efficiencies/elasticities of labour productivity function.
The values of estimated coefficients derived with the pooled data of Andhra Pradesh and Punjab are presented in Table 9.4.

(a) Animal capital, farm machinery, literacy and credit availment are all found to have positive and significant impact on labour productivity.
(b) The Adj. $R^2$ of 38%, even though low, appears to support the validity of the model.

State-wise elasticities of labour productivity are shown in Table 9.5

* With respect to results on Punjab:
  (a) Only farm machinery and credit availment are found to have positive and significant influence on labour productivity. Literacy even though insignificant, is positively related to labour productivity.
  (b) The low Adj. $R^2$ of 29% is indicative of ‘inadequacy’ of the specified model.

* With respect to results on Andhra Pradesh:
  (a) The regression coefficients of animal capital, literacy and credit availment are found to have positively significant impact on labour productivity. Farm machinery variable, even though negative, is statistically insignificant.
  (b) The low Adj. $R^2$ of 8% does not in way validate the model specified for explaining variations in labour productivity at farm level.

* With respect to results on Orissa:
  (a) The coefficients of animal capital and farm machinery are found to have positive and significant impact on labour productivity. Literacy variable, even though statistically insignificant, has expected positive impact on productivity of labour.
(b) The low Adj. $R^2$ of 20% does not appear to validate the specification of the model.

Farm-size-wise Results on Labour Productivity (Table 9.6):

* In case of Marginal and Small Farms:
  (a) The coefficients of animal capital, farm machinery, and literacy are not only significant, but are also found to have positive impact on labour productivity. Credit availment, even though insignificant, is found to have positive impact on labour productivity in marginal and small farms.
  (b) The Adj. $R^2$ of 37%, even though small, validates to some extent the specified model.

* With regard to Semi – Medium and Medium Farms:
  (a) The coefficients of farm machinery, literacy and credit availment are both positive and significant. The coefficient of animal capital, even though insignificant, is positive.
  (b) The Adj. $R^2$ is adequate enough to support the validity of the specified labour productivity function in case of semi-medium and medium farms.

* In case of Large Farms:
  (a) The elasticities of labour productivity with respect to farm machinery and literacy are found to be positive and almost significant. But the negative coefficient of animal capital is disturbing, and it is almost significant. The coefficient of credit availment variable, even though insignificant, is found to have positive impact on labour productivity.
  (b) The high Adj. $R^2$ of 71% supports the validity of the estimated labour productivity model.

There is a need for stating that the coefficient of irrigation variable is negative and significant in both GVO and labour productivity functions (aggregative as well as disaggregative functions), excepting a couple of
cases. It is not clear whether these significant but negative impacts are due to some ‘aberrations’.

9.3 Capital Formation Function Estimates:

In Tables 9.7, 9.8 and 9.9, results on capital formation function estimation are presented:

- The results (Table 9.7) with pooled data analysis of Punjab and Andhra Pradesh sample farmers suggest that:
  
  (a) The coefficient of land, credit availment, and literacy are positive as well as statistically significant.
  (b) The Adj. \( R^2 \) of 36% suggests that the independent variables could explain only 36% of variation in capital formation at the farm level.

- The state-wise results are in Table 9.8
  
  * The results with data from Punjab farmers indicate that:
    
    (a) The coefficient of land is high (0.944), and statistically highly significant. The coefficients of both literacy and credit availment are positive, but statistically insignificant.
    (b) The Adj. \( R^2 \) of 46% is moderately high enough to explain variation in capital formation at farm level in Punjab.

  * In case of Andhra Pradesh:
    
    (a) The coefficients of land as high as (0.999) and credit availment are both positive and statistically significant. The coefficient of literacy, even though statistically insignificant, is positive.
    (b) Low Adj. \( R^2 \) of 16% does not validate the explanatory power of the model.

  * In case of Orissa:
    
    (a) Both land, literacy variable are statistically significant in explaining variations in capital formation, and both have positive impact.
(b) The Adj. $R^2$ of 32% suggests that the specified model cannot explain most of the variations in farm level capital formation.

● Farm - size - wise results are in Table 9.9

* In case of Marginal and Small Farms:
  (a) The coefficients land, credit availment, and literacy are positive as well as statistically significant.
  (b) With Adj. $R^2$ of 28%, the specified model can explain only 28% of variation in capital formation in marginal and small farms.

* With regard to Semi - Medium and Medium Farms:
  (a) The efficient of land alone is both positive and significant. The coefficient of credit availment is positive, but insignificant, and that of literacy negative but insignificant.
  (b) The Adj. $R^2$ of 41% is moderate enough to explain 41% variation in farm level capital formation.

* In case of Large Farms:
  (a) Credit availment alone is found to be both positive and significant. The coefficients of literacy and land are both positive, but statistically insignificant.
  (b) The estimated capital formation function can explain 56% of variation in farm level capital formation.

10. SUBSTANTIVE INFERENCES, CONCLUSIONS AND POLICY DIRECTIONS:

The focus of this section is to recapitulate major inferences and conclusions of the study, and to derive pathways and policy directions. Recapitulations are on cross-country experiences as related to capital formation in agriculture, growth and poverty alleviation, on macro evidences from India related to this theme, on capital growth performance of sample States and farm groups, on compositional shifts in capital stock and capital intensity, on factor-intensity and factor-
productivity, and on empirical results on determinants of gross value of output, labour productivity and farm level capital formation.

10.1 About the Study:

The imperatives of Indian agricultural growth, and concerns, complexities and drivers of agricultural growth have drawn enough attention. This is because of the well established positive relationship between agricultural growth and poverty reduction. Further, the nexus among Agricultural Capital Stock (ACS), agricultural growth, productivity of labour engaged in agriculture, and prevalence of hunger and poverty has been validated by cross country development experiences. But the studies to establish this nexus are based on macro level data. With respect to capital formation in/for agriculture in India, about 76% is from private sector, with farm household investment forming over 70%. Hence the need for micro level farm level studies on various aspects of capital formation in Indian agriculture. The Policy and Programme Support Division (TCS) of FAO has initiated this study.

The specific objectives of the study are to analyse the growth rates of capital stock at farm level, compositional shifts, factor-intensity and factor productivity and determinants of farm level GVO, productivity of labour and capital formation as well as to identify policy interventions and directions.

10.2 Data Set:

The objectives lined up for the study are assessed, using farm level data collected by Directorate of Economics and Statistics (DES) Ministry of Agriculture, Government of India across the Country. There are two data sets of DES used in the present study viz aggregative data set for 15 States of India on land, animal capital, irrigation capital and farm machinery for the years 1994-95 and 2007-08. Three States viz Punjab, Andhra Pradesh and Orissa, based on the criterion
of land productivity have been selected, Punjab representing high productivity State, Andhra Pradesh medium productivity State, and Orissa low productivity State. The total sample from these States would come to 1350 for two years viz 1994-95 and 2007-08. The data set is amenable for analysis of both aggregative (State), and disaggregative (farm size group) levels. Since the values of land, animal capital, farm machinery and irrigation capital were in present values of the years 1994-95 and 2007-08, they have been deflated into values at constant prices, using the deflators developed by Central Statistical Organisation (CSO), Government of India with 1999-2000 as the base year. Gross value of output for these two years has been converted into value at constant prices, using the deflater derived from GDPA at current and constant prices (with 2004-05 as the base), reported in National Accounts Statistics of Government of India.

10.3 Major Development Experiences:

Before discussing the results from the present study, four cross country development experiences are stated as a back drop. First, growth accounting studies have validated the thesis that capital (in the broad sense) is one of the critical factors for growth. Further, capital accumulation is a major factors for ‘catch up’ in growth path and for growth convergence across countries. Second cross region studies on developing countries have also validated the thesis that capital is one of the deep drivers of growth, and capital deepening (more capital for labour to work with) is quite indefensible for increasing the productivity of labour and thereby addressing the issue of poverty and hunger. Third the cross country studies have further established the closer link between agricultural growth and poverty reduction. Added to this is the development experience of positive association between capital formation and agriculture productivity, and positive association between agriculture productivity and poverty reduction. This establishes the relationship between capital stock and
poverty, a major development policy goal. Fourth, macro level evidences from India are also suggestive of the inference that capital formation, agriculture productivity/output growth, and poverty reduction are closely related. It is true that there are many domains in which policies are needed for leading Indian agriculture from decelerated to accelerated growth. Among critical areas of agriculture policy, capital formation is a major policy domain for the reasons of decline in growth of capital stock in agriculture at macro level, and negative growth rates of non-land capital assets at farm level, as evidenced from the present study. Judious use of natural resources for sustained agricultural growth, adoption of technology, development of infrastructure, ensuring food security and making agriculture a profitable enterprise are the issues which can be addressed with a strong capital base, among others.

10.4 Growth Rates, Composition of Capital Stock and Capital Intensity: Aggregative Analysis

Three major results derived from pooled data of fifteen States are extracted:

- First, the results on growth rate analysis suggest there was hardly 0.72% growth rate of non-land capital stock (animal capital, farm machinery and irrigation capital) between 1994-95 and 2007-08.

- Second, among four capital items (land, animal capital, farm machinery and irrigation capital) the share of land is found to be 94% in 1994-95 and 95% in 2007-08, leading to the inference that non-land capital assets formed only 5% of the total capital stock in agriculture. Declining share of land in value of total capital stock is an observed phenomenon in developed countries. Among non-land capital assets, a decline in the percentage share of animal capital and an increasing share of both farm machinery and irrigation capital are very well recorded.
Third, the trends in non-land capital intensity analysis suggests declining value of animal capital for every unit of farm machinery and for every unit of irrigation capital. As between farm machinery and irrigation, farm machinery had established increasing importance vis-à-vis irrigation capital.

10.5 Agro – Economic Features of Sample States:

- Between 1994-95 and 2007-08, there was quite a decrease in the non-land capital stock in high productivity (Punjab) and medium productivity (Andhra Pradesh) States.
- Per hectare productivity of land is found to vary positively with non-land capital stock per hectare.
- Non-land capital assets per unit of labour and productivity of labour are also found to vary positively.
- Productivity of land and percentage area irrigated area are also positively related.
- Rural/urban poverty is negatively related to intensity of capital stock, productivity of land, productivity of labour and intensity of irrigation.

10.6 Aggregative and Disaggregative Analysis of Capital Growth Rates, Compositional Shifts, Factor - Intensity and Factor - Productivity:

The aggregative analysis is performed with the results from pooled data set of all the three States, and the disaggregative analysis with the results from individual States, and from three farm groups defined for the purpose of this study.

10.6.1 The Aggregative Results from Pooled Data Set of Three States:

- The overall growth rates of all the three non-land capital assets are found to be negative as between 1994-95 and 2007-08 in
sample States. A stronger negative growth trend is in case of irrigation capital.

● The results on compositional shift suggest that land continued to be dominant capital asset to farmers, with land forming 95% of total capital stock during 2007-08, and three non-land capital stock constituting only 5%. With respect to the share of irrigation capital among non-land capital assets it had experienced a greater decline in its share, and farm machinery continued its share dominance of over 40%.

● The factor-intensity analysis suggests that non-land capital stock per hectare had declined between 1994-95 and 2007-08. There was also a marginal decline in non-land capital stock per unit of labour.

10.6.2 The Disaggregative Results: Farm - Size - Wise Analysis:

A. The overall Performance of Marginal and Small Farms:

* With respect to capital growth performance, these farms of all the three States had experienced negative growth rates in land, animal capital and irrigation capital, and there was a positive growth rate in case of farm machinery. The high negative growth rate (-7.1% and as high as -16.7% in Punjab) of irrigation capital is a disturbing trend, since irrigation capital is a land substitute (and thereby land augmenting) for these small holdings.

* In overall capital composition of marginal and small farms, land dominated with around 94%, and the remaining 6% shared by non-land capital assets during both the periods.

* With regard to composition of non-land capital assets of these farms, there was a considerable fall in the share of animal capital and farm machinery during second period and increase in the share of irrigation capital.
Regarding factor intensity, there was some increase in capital stock per hectare and per unit of labour during second period.

GVO per unit of labour, capital and land had increased during second period vis-à-vis first period.

B. The Overall Performance of Semi – Medium and Medium Farms:

* The growth rates of all capital components were negative, the highest negative growth rate recorded in case of irrigation capital.

* With respect to composition of total capital stock, land dominated the share with 96%. With respect to composition of non-land capital stock alone, there was a fall in the share of farm machinery, but increase in the share of irrigation capital.

* Regarding factor-intensity ratios, there was a marginal decrease in capital stock per unit of land and increase per unit of labour.

* But there was an increase in GVO per unit of land, labour and capital during second period.

C. The Overall Performance of Large Farms:

* The overall growth rates of all capital components of large farms were negative, excepting the marginal positive growth of land. The highest rate of negative growth (-6.4%) had taken place in case of irrigation capital, followed by farm machinery (-3.4%).

* The percentage share (94%) of land has the dominant capital asset in the composition of total capital stock, with 6% contributed by all non-land capital stock. Regarding composition of non-land capital assets, the share of irrigation capital and farm machinery had declined, whereas the share of animal capital had increased.
With respect to overall capital intensity, there was a decline in capital stock per unit of land as well as per unit of labour.

The overall results on factory productivity suggests an increase in output (GVO) per unit of labour, capital and land.

10.6.3 Recapitulation of Results on Determinants of Gross Value of Output, Productivity of Labour and Capital Formation:

(a) Cutting across different versions of aggregative, Statewise and farm-size-wise analysis, output elasticities of animal capital, farm machinery, land, labour, and credit availment have turned out to be important determinants of farm level gross value of output.

(b) With respect to estimates of labour productivity elasticities (ignoring differences in different versions of estimates), animal capital, farm machinery, literacy and credit availment are found to have positive impact on labour productivity.

(c) In general the major determinants of farm level capital formation are identified to be land, credit availment, and literacy level of farmers. It is recalled from Section 4.5.2 C that terms of trade and technology are two important determinants of farm level capital formation. Lack of data on technological status of individual farmers, and same value of terms of trade for all sample farmers prevented the inclusion of these two variables in capital formation function.

10.6.4 Pathways and Policy Directions:

Based on the major inferences and conclusions of the present farm level study, and of macro level studies (Bisaliah 2004 and 2010) on capital formation, agricultural growth and poverty, the pathways and policy directions are suggested.

● The major development experience derived from the cross country studies on capital formation, agricultural growth and poverty is recalled to “establish” the need for placing the agricultural/rural sector on the top of development agenda. The
The major inference derived from these studies is that there is a positive relation between capital formation and agricultural productivity/output growth, and negative relation between agricultural growth and prevalence of poverty. Added to this the positive relation between Agricultural Capital Stock (ACS) and productivity of labour engaged in agriculture, and negative relation between productivity of labour and prevalence of hunger and poverty. Macro level studies on these relations have also validated the theorem on capital formation, agricultural productivity/output, and poverty.

The present study of three sample States on the relationship between capital stock, land and labour productivity in agriculture, and rural poverty (Table 6.1) has clearly derived two major inferences. First, there is a positive association between intensity capital and productivity of land and labour. Second, there is a negative association between intensity of capital stock and rural poverty, between productivity of land and rural poverty, and between productivity of labour and rural poverty. Hence the major development experience derived from cross country studies and from cross-State studies of India would indicate the pathways for placing more emphasis on capital formation in/for agriculture, and on placing agriculture/rural sector on the top of development agenda of India so as to facilitate the realisation of development policy goals such as employment creation, poverty alleviation and reduction in development divide between urban and rural areas.

It is recalled from the present farm level study that:

- There was hardly 0.72% growth rate of capital stock between 1994-95 and 2007-08 in all the fifteen States. In the total capital stock, the percentage share of land capital was 95%, non-land capital assets forming only 5% of total capital stock.
Between farm machinery and irrigation capital, there was more of farm machinery for every unit of irrigation capital.

All these results would be suggestive of low growth rate of non-land capital stock, dominance of land capital and low growth of irrigation capital.

● The empirical evidences from the study of three States (with a total sample of 1350 farm households) are enough to gauge the negative growth rate of all the non-land capital stock (with a stronger negative grow rate in case of irrigation capital), dominance of land capital forming 95% of total capital stock, low share (5%) of all non-land capital assets. Further, in general, capital stock per hectare of land had declined. But there was an increase in output per unit of land, labour and capital, perhaps due to efficient use of capital stock by farmers.

Hence, negative/low growth rate of non-land capital stock with a stronger negative growth rate of irrigation capital, dominance of land capital in total stock of capital assets and declining capital stock per unit area cultivated would provide enough evidences in favour of a strong policy support for capital formation at farm level from where over 70% of agricultural capital stock in India comes from.

● With respect to determinants of output (GVO) at farm level, of labour productivity and capital formation: (a) Animal capital, farm machinery, land, labour and credit availment are turned out to be major determinants of farm level output. (b) Animal capital, farm machinery, literacy and credit availment are identified as the major determinants of productivity of labour engaged in agriculture. (c) Land, credit availment and farmer literacy level are important determinants of capital formation at farm level. The reasons for not including two important determinant viz terms of trade and technology have been stated under Section 10.6.3.
Given the empirical evidences from the present farm level study on capital growth, capital composition, factor intensity and factor productivity, and determinants of farm level output, labour productivity and capital formation, the next issue is to identify policy directions. As discussed at the beginning of the present Section (Section 10.6.4), policy direction are derived from both the macro and micro level evidences (from the present study) on capital formation and associated factors. Macro level studies (Bisaliah 2004 & 2010) are the basis for deriving the policy directions.

First, due to political economy compulsions leading to the diversion of public investible funds to subsidies, the well “established” theorem that public investment in capital projects is one of the major determinants of farm level investment through inducement effect, appears to get less attention. It has been established that long-term public investment in capital projects would give rise to more than double the rate of return from subsidies. Gradual withdrawal of subsidies especially for irrigation water, electricity, fertilisers and pesticides would provide a large pool of resources for public investment. It is possible to ‘compensate’ the farmers through more public investment in the areas such as agricultural R&D, rural roads, markets, and storage structures. For example, crop diversification towards high value horticulture crops (due to high income elasticity of demand for fruits and vegetables both in the domestic and international markets) cannot be sustained without the support of non-price factors and only with price-inducement effect. The support of non-price factors will have to come from public investment in agricultural science and technology and infrastructure, perhaps with in a partnership mode involving corporate sector. In fact, any effort to make Indian agriculture competitive needs the support of agriculture R&D for yield-augmentation unit cost reduction and...
quality augmentation at farm level. The investment in agriculture R&D comes from both public and private sectors. Hence public-private sector partnership for both complementary and independent role is needed to support farm level capital formation.

**Second,** it needs to be realized that public and private sector investment portfolios tend to be different in view of difference in objective functions governing their investment decisions. Hence private investment cannot always be a substitute for public investment. The Structural Adjustment Programme (SAP) prescribes lower public expenditure and reduction in development role of the State assumes that private investment will rise when public investment declines (crowding out/in effects). But the larger development agenda is not expected to be addressed by the private sector, and the larger development agenda continues to be the domain of public sector investment. Areas like watershed, large and medium irrigation projects, agricultural research and extension, and market infrastructural continue to remain primarily in the public sector domain, of course in public-private sector tie-up wherever possible. Further, public investment in rural infrastructure, comprehensive reforms of market institutions and regulations and supportive policies are quite indispensable for stimulating both domestic and international investment in agricultural/rural sector. Hence, in the absence of adequate public investment in critical areas, the strategy of fast-track privatisation is not likely to occur.

**Third,** there are enough empirical evidences (Recall results in Table 6.1) to indicate regional agricultural development disparities. It is rightly argued that investment in backward States has greater productivity-enhancement effect (in the sense of incremental effect) than investment in favoured regions. Obviously public investment portfolio could be different for these
two broad groups of agricultural regions. Corporate sector investment tends to flow more into ‘favoured’ regions. Pro-active role of public sector investment in backward regions would not only induce private farm investment (both farm household and corporate investment), also contain the problems of development distance between favoured and backward regions. Further, it is reported (see Bisaliah 2004 for details) that compared to northern States of India, the estimated ICOR are lower particularly in the Eastern States. These States would special consideration for public investment, not only because of their higher capital use efficiency, but also these are the States where majority of the rural poor are concentrated.

**Fourth**, it is recalled that growth rates of all non-land capital assets have been negative much more so in case of irrigating capital stock. The small and marginal farmers which form more than 80% of the holdings in the State need more of public investment support in areas such as community irrigation projects and group marketing of output. In the absence of development support from public investment, these farmers are likely to face heavy cost of transition from protective to competitive agriculture.

**Fifth**, as evidenced from the present farm level study, credit, among other, is found to have positive impact on output (GVO), productivity of labour and capital formation. Macro level studies have also arrived at the inference that institutional credit, public investment, terms of trade, flow of technology, and subsidies (less attractive than public investment in capital projects) are the major determinants farm household investment. There are areas where policy initiatives are need for “mobilizing” credit as well as other factors as instruments for the purpose of augmenting productivity/output growth in agriculture, labour productivity and capital formation. (a) The private investment is induced by public invest, and the critical areas (such as irrigation, rural
infrastructure and so on) where public investment is needed has already been discussed in the earlier Sections. (b) The positive impact of terms of trade on private investment would challenge the policy of total withdrawal of subsidy. Hence, there is a need for policy initiatives to withdraw subsidies in a phased manner and to plough back these funds for public investment in capital projects in agricultural/rural sector. Further, subsidies on development of private irrigation, agricultural implements/machinery, land development, and animal husbandry may be needed for targeted group of farmers. (c) In view of positive impact of credit on farm output, labour productivity and capital formation, a critical review of rate of interest, credit limit, repayment schedules and quality improvement in credit delivery system is needed. Further, is the policy initiative for considering ‘supervised credit system’ especially in case of investment credit, where some amount of ‘technical guidance’ is required for making choice of investment projects at farm level. (d) Technology fatigue and technology delivery system fatigue at farm level would warrant the enhancement of credibility of public research and extension systems by a critical review of institutional structures established for this purpose, and ‘appropriateness’ of existing research and extension priorities.

Sixth, in formulating public policies towards public investment in agriculture, three areas of priority are suggested viz rural roads, electricity and major and medium irrigation projects (Bisaliah, 2010). Technology development and transfer, development of rural non-farm sector, development of marketing system, and development support for sunrise sectors like horticulture and live stock are some other major priority areas for public investment. Some of these areas of public investment need a little more elaboration (Bisaliah, 2010).

- When it comes to public investment in irrigation, it needs to be kept in view that in the public sector investment portfolio
irrigation constitutes the single largest component. Hence there is a need not merely for more public investment in irrigation, but also need for reforms in the management and operational efficiency of existing projects. Policy initiatives are required for making the choice between new projects and better utilization of capacity of existing projects. There has been a persistent gap between irrigation potential created and actual utilization of irrigation water. In view of this gap, adequate public investment is required for increasing operational efficiency of irrigation systems so as to reduce conveyance losses, distribution and utilization of water. Further, efficiency of irrigation would also depend on promotion of institutional structures like water user associations, water syndicates like the ones in France, and village level committees for management of tank irrigation system. Public investment for renovation of water bodies initiated by Government of India could prove to be a right step for rehabilitating tanks and other traditional methods of water harvesting.

It has been very well established that rural electrification impacts agricultural productivity through farm household investment in electric pumps. But there are regions where ground water potential is underexploited, and others where it is overexploited, causing environmental concerns. Yet another problem with respect to rural electrification is transmission and distribution losses (estimated to be as high as 40%). Any effective implementation of rural electrification projects needs the support/involvement of local bodies like village Panchayats and other people’s organisations. Further public investment will have to be made for promotion of solar and wind energy for tiding over the problems like hike in prices of conventional sources, uncertainties in supply and growing scarcity. The efficiency of public investment in providing subsidies to users
of non-conventional energy sources especially for irrigation could be increased by providing subsidies to village as a unit.

- India needs productivity-led growth in agriculture in view of land constraint. This needs public investment for increasing TFP in agriculture, and TFP shifts production function upwards and unit cost functions downwards, which are very much needed for effecting transition of Indian agriculture from protective to competitive regime. The TFP growth is attributed to agriculture science and technology, irrigation, modern farm implements and rural infrastructure. But growth rate of TFP has been falling (details in Bisaliah 2010). The stagnating/declining TFP growth has serious implications for sustaining productivity growth which is critical for achieving food security, poverty reduction, and virtuous economic growth instead of enclave growth. The declining TFP in agriculture is yet another reason for public investment in agriculture as well as for ‘reducing’ the importance of conventional growth sources, and to make a transition to science-technology (both modern and traditional) based agriculture.

- Over 60% of cropped area in Indian agriculture is under dryland farming. But low productivity of dry land farming due to hostile agro-climatic regime, and these are the regions where the majority of the rural poor live. Farmers in these regions are confronted with the challenge of degraded and depleted natural resource base, biological disequilibrium, and adverse impact of climate change. More of public investment in water and soil resource development of these regions would be a key factor for accelerating the public policy support for implementing the concept of ‘Build on the Rest’, in addition to ‘Build on the Best’. Exploitation of potential of dryland farming itself could be a new source of growth in Indian agriculture.
Rural economic diversification would provide more livelihood options for the poor. Development of non-farm sector could become an escape route for agriculture workers, for reducing demographic pressure on land and for diversifying income and employment opportunities for the poor. Chinese experience (Dev, 2008) on rural transformation offers several lessons to India as well as to other developing countries. Chinese Government has recognized that agriculture growth is only a necessary, but not a sufficient condition for alleviating poverty. China’s rural industrialization strategy is a case in point. The rural town-ship and village enterprises (like agro-processing and value addition) have played a significant role in Chinese rural economic growth. But his kind of growth of non-farm sector needs the support of ‘big push’ in public investment especially in rural infrastructure such as roads, markets, electrification, technology generation and transfer, Government supported credit system and so on to impact positively both farm household and corporate sector investment.

Finally, public policy support is needed for institution transformation through social capital accumulation such as preparing stake holders for collective management of agricultural development programmes such as extension services, water resource management, and management of other rural infrastructure. Mobilizing farmers group as a development unit for watershed/catchment management/integrated pest management/credit delivery, and for forging the development alliance with corporate sector is quite a development support strategy. These local groups, guided by external professionals, could contribute for augmentation of human capital in rural areas which could be a major deep driver of rural growth and which could contribute for increasing marginal efficiency of both public and farm household
investment. Both capital accumulation and assimilation of efficiency contents of capital stock will be facilitated by human capital at farm level.