

## CAPITAL FORMATION IN INDIAN AGRICULTURE: GROWTH, COMPOSITION, DETERMINANTS AND POLICY DIRECTIONS

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### 1.0 The Major Issues: Concerns and Controversies

The nexus between capital formation and agricultural growth, and agricultural growth and poverty alleviation are very well articulated in literature. Given the positive impact of agricultural growth on poverty alleviation, the role of capital formation as one of the major engines of agricultural growth has been well placed in the development policy perspective. There are some major streams of research on capital formation that have sharpened this role in the development policy perspective.

- 1.1 The first major bout of interest on capital formation in Indian agriculture was generated by Tara Shukla's (1965) study for selected years during 1920-21 to 1960-61. The second major bout of interest on this area of research was in late 1980s and early 1990's, bringing out the issue of fall in public investment in agriculture during 1980s, echoing neglect of agriculture in public resource allocation and its adverse impact on private investment (in the context of complementarity between public and private investment in agriculture) as well as agricultural growth and equity concerns of development policy of the country. Following this bout, the next stream of research studies on capital formation since the middle of 1990s have broadened and deepened the concerns and controversies. These concerns and controversies center around some major issues on capital formation such as declining public sector investment in agriculture, confirming/refuting complementarity between public and private investment, compositional shifts in capital formation, determinants of public and private sector investment behaviour, inter-State disparities in capital formation and their implications for transfer of resources by Central Government to State governments, impact of capital formation on agricultural growth, efficiency in capital use, and needed policy directions for matching growth in capital formation with targeted output growth rate in agriculture, and capital formation in agriculture and for agriculture.
- 1.2 The preceding issues on capital formation have been addressed by researchers from three major directions. First is the choice of data set and time frame of the study. There are three major data sets used by researchers for testing their hypotheses on various aspects of capital formation. The Central statistical Organization (CSO) investment data series (called narrow coverage data set), broad series developed by using data available in Financial Accounts of Central and State Governments on major heads relevant to capital formation, and the methodology suggested by Bhattacharya Committee (2003) for regrouping CSO data series into a comprehensive data set on capital formation in/for agriculture have contributed for and attempted to throw more light on the issues surrounding capital formation. More on this later. Second, serious research attempts have been made with respect to complementarity issue and its implications for agricultural growth as well as agricultural development policy by articulating the issue in the framework of macro and micro evidences. Third, use of multivariate analysis instead of single explanatory approach, and simultaneous equation approach instead of single equation approach have been attempted to resolve the controversies and to add to the controversies as

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well. The choices of analytical devices have been made especially with respect to determinants of capital formation (particularly in the context of complementarity hypothesis), determinants of agricultural productivity, and capital formation and poverty alleviation via agricultural growth.

1.3 Following the backdrop preceded, the objectives of the present study are set out as below:

- Identify investment growth cycle and compositional shifts in investment in agriculture.
- Assess the determinants of capital formation in public and private sector, and the complementarity hypothesis in a multivariate framework.
- Analyze State-wise disparities in investment intensity.
- Evaluate the shifting efficiency of capital use in agriculture.
- Analyze the impact of capital formation on agricultural growth vis-à-vis other explanatory variables.
- Derive policy directions/reforms for augmenting the level and shifting the composition of capital formation in/for agriculture.

2.0 Data Base and Coverage

What should constitute capital formation in agriculture has been one of the methodological controversies raised by researchers. This has led to the distinction between capital formation in agriculture and capital formation for agriculture (Dantawala, 1986).

2.1 CSO is a source of information on capital formation in agriculture as a part of compilation of National Accounts Statistics (NAS) in accordance with the concepts and definitions in the System of National Accounts (SNA) of United Nations. Hence CSO has organized estimation of capital formation in agricultural sector, and estimation of public and private investments as part of NAS.

The data set provided by CSO is termed as narrow in its coverage, because the estimation includes public investments in irrigation schemes, and plantations in the forestry sector. In fact, irrigation schemes form more from 90% of public sector investment in agriculture. The CSO series do not include public investment in important infrastructure like rural electrification, market, storage, rural roads and the like, which have bearing on agricultural growth and development. Further, CSO series, even though consist of private investment of both household and private corporate sector at national level, do not provide state level estimates of public and private investments corresponding to national estimates.

2.2 Realizing the narrow coverage and restrictive nature of CSO series, three major attempts have been made to develop broad investment data series to reassess the inferences (on major issues of capital formation) drawn based on CSO series. First, Chand (2000), using the data available in Financial Accounts of Union and State Governments for 23 years (1974/75 – 1996/97) has developed investment series called broad series. These series cover capital expenditure in public sector under 23 heads, including the ones in CSO series and investment in fertilizer industry and district and other roads. Chand (2000) has also developed time series data on private investment at state level, using data generated by Reserve Bank of India under All India Debt and Investment Surveys (AIDIS), data generated by National Sample Survey Organization (NSSO) under Household Capital expenditure, and the National Level Private Investment data developed by CSO.

2.3 Roy (2001) has also developed broad investment series on public investment by considering capital expenditure under 21 heads (including the ones in CSO narrow series), and 50% of revenue expenditure on rural development, and agricultural research and education. Using the time series data on national level private investment by CSO, and data generated by Reserve Bank of India through AIDIS and

by NSSO under household Capital expenditure, Roy (2001) has developed time series state level data on private investment.

- 2.4 Gulati and Bathla (2002) have evaluated the major issues of declining public investment in 1980's, complementarity hypothesis and impact of capital formation on productivity growth, using three concepts of public investment in agriculture viz., concept-I as used by CSO covering basically Government investment in irrigation schemes, and plantations in the forestry sector; concept-II comprising components of concept I plus part of the investment in power sector that goes to agriculture, as estimated by Central Electricity Authority/Planning Commission, concept III comprising of components of concept II plus investment in agriculture and allied sectors under 11 items of expenditure (as per budgetary classification) under centrally sponsored schemes.
- 2.5 Recently Bhattacharya Committee (2003) has argued for developing investment series, keeping in view the difference between capital formation in agriculture and for agriculture. The Committee recommends that capital expenditure data on ten sectors available in CSO estimates be regrouped to get an estimate of capital formation for agriculture. These ten sectors are agriculture and allied sectors, manufacturing (fertilizers, pesticides, agricultural machinery, etc.), electricity, construction (irrigation structures, rural roads, agricultural markets, etc), trade, railways/shipping/airways/roads, storage, communication, banking and insurance and public administration (capital expenditure on rural development, crop husbandry, soil and water conservation, preservation of wild life, etc.).

Further the committee has recommended the development of yet another data set on capital formation for agriculture, by including additional items not in SNA basket. In the CSO estimates of capital formation, the expenditure on R & D, training, extension services and agricultural education are not included. These expenditures would enrich human capital, leading to increased productivity in agriculture. Further, expenditures on conservation of forests and environment also qualify for inclusion as capital formation. However, any attempt to expand the data set for including expenditure on education as investment in human capital may also invite suggestions for including public expenditure on health, housing and food, etc., as investment in human capital. Hence, too much broadening of the concept of capital formation for agriculture may raise the methodological controversy of benefit gestation period, apportionment of expenditure towards consumption and production components of expenditure, etc. However, data set on these items of expenditure may be of help for monitoring supportive and sustaining factors for agriculture and rural development.

The basic question that needs to be addressed is whether the inferences derived from the research studies based on CSO data set are different from those derived from broad investment series, making allowance for time period of studies. Section 3.0 would address this question.

### 3.0 Growth – Deceleration and Shifting Composition of Capital Formation

It is recalled from section 1.3 that one of the objectives of the present study is to identify the investment growth cycle (i.e., the period of growth and deceleration in capital formation in agriculture) and compositional shifts in investment in agriculture. The growth-deceleration analysis is meant to identify the period of growth, the period of deceleration, and the direction of change in public and private investment, and to bring out the implications of investment growth – deceleration pattern to agricultural growth. This analysis is performed with both CSO investment series and broad investment series. The shifting composition analysis is directed to answer the questions whether the relative share of public and private investment has changed over a period of time, what trends could be observed in the relative share of agriculture and allied sectors vis-à-vis the share of forestry and fishery sectors, whether the share of investment made by Departmental Commercial Undertakings (DCU) under public sector investment has altered in relation to the share of

investment by Non-Departmental Commercial Undertakings (NDCU), and what kind of compositional shifts have occurred in farm household capital expenditure in agriculture.

### 3.1 Growth-Deceleration pattern analysis

Since 1989, the research studies on trends in capital formation in Indian agriculture have given rise to many concerns and controversies. CSO investment series-based studies have identified a kind of growth cycle in capital formation. This growth cycle encompasses rising trend during sixties, relatively subdued phase during the first half of seventies, momentum of peak phase during second half of eighties, and a persistent decline thereafter. This persistent loss of momentum is considered as a disquieting development, with implications for agricultural growth. Further, while analyzing the growth rate of public and private investment, the low positive growth rates of private investment has been not enough to compensate the negative growth rates in public investment, leading to a loss of momentum in total GFCF in agriculture.

3.1.1 Given the above broad concerns, the growth-deceleration syndrome could be gauged from different angles. First, what have been the trends in agriculture GFCF vis-à-vis aggregate GFCF? Second, how different are the temporal shares of aggregate GFCF in GDP and of agriculture GFCF? Third, whether the share of agriculture GFCF in agriculture GDP has altered over a period of time? Fourth, how comparables are the annual growth rates of public and private investment in agriculture? Fifth, whether the conclusions derived from CSO investment series analysis different from those of broad investment series analysis? The subsequent sections examine the evidences on these as well as related issues.

3.1.2 One of the ways to identify investment growth-deceleration epochs is to analyze the aggregate growth rates of GFCF and of agriculture GFCF. Two broad results on this could be extracted from Table-3.1:

- The annual compound growth rates of aggregate GFCF increased from 4.35% during 1960/61 to 1980/81 to 5.85% during 1980/81 to 1999/2000. Whereas the corresponding growth rates in agriculture and allied sector decreased from 6.2% to 1.83%. In case of agriculture alone, the decline was still more.
- These broad conclusions are further reinforced by decadal growth rates. In case of agriculture and allied sectors, and agriculture alone, the growth pattern experienced negative growth in 1980s, and a reversal to positive growth in 1990s, but far lower than that of the growth rates of sixties and seventies.

3.1.3 Growth-deceleration pattern could also be analyzed with shares of aggregate GFCF in GDP and of agriculture and allied sectors in GDP. As observed from Table-3.2.A, the decadal averages of aggregate GFCF as a percentage of GDP increased from 17.4% in 1960s to 22.1% in 1990s. In case of agriculture and allied sectors, the share had declined from 2.5% to 1.7% during the same decade. An examination of results reported in Bhattacharya Committee Report (2003) would reinforce this conclusion. As per cent to GDP, GFCF in agriculture had declined from 3.4% in 1980/81 to 1.6% in 2001/02. The corresponding share of GFCF for agriculture had decreased from 4.3% to 2.3%. Further, the share of public sector GFCF in agriculture in relation to GDP had declined from 1.8% in 1980/81 to 0.4% in 1999/2000. The share for agriculture had declined from 2.5% to 0.9% during the same period.

In this perspective of declining trends in capital formation, an examination of share of agriculture GDP in aggregate GDP is in order. It could be seen from Table-3.2.B that the share of agriculture GDP in aggregate GDP had declined sharply between 1960s and 1990s. It is not clear whether this is a part of structural transformation in growth

process, and part of that could be attributed to declining investment in and for agriculture. More on this later.

- 3.1.4 An examination of results in Table 3.3 would further reinforce the argument that the share of agriculture and allied sectors in total GFCF had been halved between 1960s and 1990s. The share of agriculture and allied sectors (agriculture alone) experienced drastic decline from 14.4% (13.5%) to 7.8% (6.9%) between 1960s and 1990s.
- 3.1.5 What have been the trends in agriculture GFCF as percentage of agriculture GDP? It could be observed from Table-3.4 that the percentage share of agriculture GFCF in agriculture GDP was lower in 1990s than either in 1970s or 1980s, but marginally a little higher than in 1960s. Hence, the growth of GFCF in agriculture experienced decline in momentum in 1990s.
- 3.1.6 The growth-deceleration syndrome could also be examined with annual growth rates of public and private investment. It follows from Table-3.5 that public sector investment growth rates, which were quite high during 1970s, became negative during 1980s, and deceleration declined during 1990s. Private sector investment growth rates were positive although 1960s and 1990s; but lower rates were experienced during 1980s and 1990s, even though there was some improvement in 1990s over 1980s. Further with regard to private sector growth rates, the increase in growth rates in 1990s over 1980s was higher in agriculture and allied sector than in agriculture proper, implying some degree of diversification of investment portfolio in farm sector.

A closer look at the investment growth rate performance of public and private sector during eighties and nineties would provide yet another perspective into deceleration syndrome. As evident from Table-3.6, during the period of 1982 to 1992, the negative growth rate in public sector was compensated by high growth rate in private sector, giving rise to less than 2% overall growth in investment. Further, weak performance of public sector in nineties was somehow offset by respectable growth rates in private investment during the period of 1992-99 and 1992-97 so as to generate an overall investment growth of over 2%. But during the period of 1997/99, the negative growth rate experienced in public sector investment could not be offset enough by positive but low growth rate in private investment, so as to maintain the tempo of 1992/99 and 1992/97. Since, private sector investment accounts for over 70% of investment in agriculture, any slowdown in private investment will have implications for growth of agricultural sector. Further, any weak performance of public sector investment would imply decline in investment in surface irrigation system.

- 3.1.7 The declining trend in public sector investment in agriculture could also be examined under three concepts of public investment developed by Gulati and Bathla (2002). The results for the period 1974/75 to 1998/99 are presented in Table-3.7. First, the absolute volume of investment increases as we move from one concept to another. The differences were quite substantial (almost double) as between C-I and C-III in 1974/75. The differences were narrowed down by the year 1998/99. Second, percentage change in volume of public investment in 1984/85 over 1974/75 was both positive and substantial. But the percentage change in 1994/95 over 1984/85 was negative under all three concepts, implying declining public investment in agriculture. However, the decline is found to be less in 1998/99 under C-I and C-III. Third, public sector investment in real terms, whatever the concept used, declined after 1980s, even though the decline was less during the later part of 1990s. In a state level study, using broad investment series concept, Roy (2001) has reported declining trend of public investment in real terms across the board in most of the states since mid 1980s.
- 3.2 Analysis of compositional shifts

It is recalled from section 3.1 that the share of private sector in capital formation has been increasing over time. This requires further analysis from the direction of shifts in the share of public and private sector in total investment over a period of time. Table-3.8 and 3.9 would provide some useful insights into this question. It could be seen from Table-3.8 (CSO series based analysis) that the share of public sector had declined from about 46% in 1960/61 to about 24% in 2002-03, and correspondingly the share of private sector had increased from about 54% to 76%. Part of this could be explained in terms of changing role of public sector in development process and the ability of private sector to augment its share by utilizing the initial infrastructural facilities (like irrigation, power, storage structures, etc) created under public sector. In case of declining share of public sector investment in total investment, part of that could also be explained in terms of changing political economy compulsions. More on this later.

- 3.2.1 The declining share of public investment could also be analyzed (Table-3.9) with three data concepts suggested by Gulati and Bathla (2002). Barring a few exceptions, the share of public sector in GCF in agriculture and allied sectors is found to have declined over a period of time. The decline between 1980/81 to 1998/99 is much more visible under Concept-III and Concept-I. Perhaps this share variation during different years could be due to shifting priorities assigned in public investment for irrigation (Concept-I), irrigation plus power (Concept-II), and irrigation plus power plus eleven other items of capital expenditure under public sector.
- 3.2.2 The compositional change in public sector investment could also be examined with results in Table-3.10. Out of the total public investment made in agriculture and allied sectors, forestry and fishery, the share of fishery sector is not very negligible, but also there was a decline in its share between 1983 TE and 1998 TE, whereas, forestry sector is found to have increased its share between 1983TE and 1998TE. It is agriculture and allied sector, which accounts for over 90% of the share of public investment. However, its share was 94% in 1980s, decreased to 89% by mid 1990s, and increased to about 91% thereafter.
- 3.2.3 Yet another way of examining the compositional shift is to analyze the expenditure share of DCU and NDCU in total capital expenditure under public sector for agriculture and allied sector. As could be seen from Table-3.11, in the total public sector investment in this sector, the share of investment made through DCU is the most dominant, even though declining share is observed as between 1983 (91%) and 1998 (79%). The most important item of capital expenditure incurred through DCU is irrigation. Hence, the trend in declining public investment refers basically to decline in public investment in major and medium irrigation schemes.
- 3.2.4 Compositional shifts in public investment could also be examined with a broad investment series framework developed by Chand (2000). A few important observations could be made with the results presented in Table-3.12. First, the real annual investment in public sector had drastically declined from Rs.4,396 crore during V plan period to Rs.2,566 crore during VIII plan period. Second, public investment in irrigation schemes continued to be the most dominant item, followed by investment in food and storage, even though there was a decline in annual investment in these two items between Fifth and Eighth plans. However, these two items alone accounted for around 65% of public capital investment in agriculture. Third, even though public investment in roads continued to maintain and increase its importance, crop husbandry, fertilizer industry and cooperation are found to have their relative importance lowered.

The results derived on compositional shifts in public investment portfolio by Roy (2001) considering 21 items of public investment could also be placed in this perspective of shifting composition. During the period between TE 1967/68 and TE 1998/99, even though the irrigation schemes continued to enjoy dominant share in

public investment, its share came down from more than 43% during early period to 28% during nineties. But minor irrigation schemes, agricultural research and education, infrastructural items (like storage, market, road, electrification and credit institutions) claimed the second largest share in total public investment. The share of rural development programmes increased from a little more than 10% of total public investment to about 24% during 1990s.

3.2.5 It is recalled from Table-3.8 that the private sector had increased its share in GCF in agriculture from about 54% in 1960/61 to about 76% in 2002-03. In this context an examination of changing structure of private investment in this sector is in order. Private sector investment consists of investment by corporate sector and household sector. The investment by corporate sector could be in organized corporate sector like big plantation firms, and in unorganized corporate sector like sugar and milk cooperatives. Since this definition of corporate sector accounts for less than 5% of private investment (Gulati and Bathla, 2002), the dominant share is that of household sector which partially owns the share of unorganized corporate sector. But the definition of private corporate sector is to include (as argued by Roy, 2001) seed industry, fertilizers, pesticides, machinery, drugs, sugar, food processing, etc., its share in total private investment would be around 60%. The data on composition of capital expenditure incurred by household sector are provided once in ten years by Reserve Bank of India through its All India Debt and Investment Survey (AIDIS). Table-3.13 provides results on composition of household capital expenditure in agriculture at a point in time, and compositional shifts over a period of 20 years. It is observed that agricultural implements, machinery and transport equipment would form the most important item of capital expenditure, followed by well and other irrigation structures. These two items alone would form a little over 70% of capital expenditure incurred by household sector in agriculture during the 20 year period of study. Almost the same composition of household sector investment in agriculture is also observed at State level for 1991/92, as per AIDIS (Gulati and Bathla, 2002). It is understandable that composition of capital expenditure varies with growth/development stage of the sector, and the development incentives provided by Government. But agricultural machinery/equipment/transport and wells/other irrigation structures are likely to maintain their dominant position for years to come, even though capital expenditures for land improvement, development of orchards and plantations, and construction of animal sheds (with increased role of dairy) are likely to increase their share.

3.3 An analysis of changes in aggregate GCF and Agriculture GCF (AGCF) as well as changing relative importance of public and private sector during post-reform period vis-à-vis pre-reform period is in order. Table 3.14 would provide such insights into annual percentage change in aggregate GCF and AGCF during pre-reform period of ten years (1981/82 – 1990/91) and post-reform period of ten years (1991/92 – 2000/01).

- In broad terms, the annual positive change in aggregate GCF was greater during post-reform period than pre-reform period. The same inference could be drawn with respect to AGCF during post-reform period. This is in fact a measure of recovery (however marginal it is) in GCF in agricultural sector during post-reform period.
- However, the annual rate of change in aggregate GCF has been found to be higher than those of AGCF. It is understandable in view of shifting sector priorities of post-reform period, impacting the growth rate of capital stock.

The next issue is whether there has been a shifting importance of public and private sector during the post-reform period vis-à-vis during the pre-reform period. As could be seen from Table 3.15:

- During the pre-reform decade, public sector investment recorded a decline in its share from about 51% to 30%; whereas during the post-reform decade, the

decline was from about 29% to 23%. Hence, the decline was sharper during the pre-reform decade than during the post-reform decade.

- In case of the share of private sector in total AGCF, the increase registered was from about 49% to 70% during pre-reform period; whereas, during the post-reform period, the increase was from about 71% to 77%. Hence, the increase in the share of private sector was more during pre-reform period.

3.4 A few broad observations could be made with the preceded analysis of investment growth cycle in agriculture and compositional shifts in such investment. First, investment growth cycle has been analyzed from different angles like growth rate trends in agriculture GFCF vis-à-vis aggregate GFCF, shifting shares of aggregate GFCF and of agriculture GFCF in GDP, shifting share of agriculture GFCF in agriculture GDP, and trends in the annual growth rates of public and private investment in agriculture in relation to trends in overall investment growth. This analysis has led to a few inferences (a) The investment growth cycle encompasses rising trend, subdued phase, peak phase, persistent deceleration, and only marginal recovery (b) The annual growth rates of aggregate GFCF are found to have increased between 1960s and 1990s, whereas agriculture GFCF had suffered deceleration during the same period, (c) The share of aggregate GFCF as a per cent of GDP had increased between 1960s and 1990s, whereas the agriculture GFCF as a per cent of GDP had declined, (d) The percentage of agriculture GFCF in total GFCF had halved between 1960s and 1990s, (e) The percentage share of agriculture GFCF in agriculture GDP was lower in 1990s than in 1970s or 1980s, (f) Public sector investment growth rates were quite high during 1970s, became negative during 1980s, and there has been a decline in growth rate deceleration during 1990s. This kind of decelerating growth of public sector investment could not be compensated by respectable investment growth rates in private sector, leading to a loss of momentum in total GFCF (in real terms) in agriculture. Analysis with broad investment series has confirmed deceleration in public investment both at national and state level, (g) A decadal analysis of pre-reform and post-reform period suggests that in case of aggregate GCF as well as AGCF, the positive changes were greater during post-reform period, and the rates of change were greater in case of aggregate GCF than in the case of AGCF and (h) Decline in the percentage share of public sector in AGCF was greater during pre-reform period, and obviously the increase in the share of private sector was more during pre-reform period.

Second, the analysis of compositional shifts in capital formation has provided a few useful insights (a) In general, during early years (of the period 1967/68 to 1998/99) the share of public and private sectors in total investment was almost equal during early phase, and there has been a steady rise in the share of private investment since eighties. For example, the share of public sector investment in total investment had declined from 46% in 1960/61 to 24% in 2002-03, leading to a corresponding increase in private investment, (b) Out of the total investment in agriculture and allied sectors, forestry and fishery, the share of agriculture and allied sector has been over 90%, (c) Out of the total investment made in public sector, the investment carried through Departmental Commercial Unit (DCU) has been the most dominant one, even though the share had declined from 91% in 1983 to 79% in 1998. The most important item of capital expenditure incurred through DCU is irrigation. Hence, any decline in public investment refers basically to declining public investment in major and medium irrigation schemes, (d) Analysis of compositional shifts in public capital expenditure in agriculture with broad investment series suggests that investment in irrigation schemes, and food and storage would form around 65% of the total investment. Even though public investment in roads continued to maintain its importance, crop husbandry, fertilizer industry and cooperation are found to have experienced declining share over a period of time. The rural development programmes have experienced hike in their share, (e) With respect to composition of farm household investment, agricultural implements, machinery, equipment and

well/other irrigation structures alone would account for over 70% of capital expenditure incurred by household sector in agriculture. Almost the same composition is observed both at national and state level. It is likely that capital expenditure for land improvement, orchards and plantations and dairy sheds would increase their share in course of time, even though the dominance of agriculture machinery/equipment/transport and well/other irrigation structures would continue.

#### 4.0. Investment behaviour of Public and Private Sector: An Analysis of Investment Determinants

One of the major controversies surrounding capital formation in agriculture is what factors would govern the investment behaviour of public and private sectors. In the absence of a strong theoretical foundation, one may have to look for empirical hunches. Further, the behaviour of private investment is related to that of public investment (among other determinants) through the complementarity hypothesis.

4.1 Behaviour of public investment in agriculture is largely explained by agricultural policies of the time. An examination of this behaviour appears to have been dictated mainly by food situation of the country and agricultural policies governed by political economy of the time (Mishra, 1996; Roy, 2001 and Gulati and Bathla, 2002). One could sort out four major policy epochs in this regard. First, the food deficit facing the country after independence was compulsive enough to pilot more public investment towards the development of irrigation system. Second, the food crisis of 1960s was another major compulsion to escalate growth in public sector investment at a trend rate of 8% per annum during 1970s. The third epoch has been since 1980s when decline in public investment has been strongly voiced. The irony is that the success of green revolution strategy itself has led to the emergence of political economy compulsions, which continues to persist. The emergence of surplus produce in agricultural sector has given rise to the emergence of politically powerful farmers' groups, which have become rather powerful to dictate the priorities of public expenditure in agriculture. The first priority has been to meet the demand for production subsidies, for which, resources have to be diverted from capital account to current account. The next important priority has been to finance private sector capital formation by institutional loans and capital subsidies. Due to these political economy compulsions, the decline in public sector investment has occurred, even though total public expenditure (plan and non-plan) on agriculture has not really declined. In fact, public sector investment has become a residual claimant. The fourth epoch emerging during economic reform regime is yet to be visible. This epoch is expected to encourage crowding in by both the household and corporate sector to accelerate their investment in agricultural sector. More on this under section 8.0.

4.2 In addition to national level agricultural policies and political economy compulsions, there are certain state level determinants of public investment state level. The level and composition of public investment at state level may depend on rural literacy level, population growth, agricultural GDP, farm subsidies and grant-in-aid from central Government. An important state level study [1970/71 to 1998/99 on 17 major States by Roy (2001)] has drawn the inference that rural literacy population, agriculture GDP, and grant-in-aid from Central Government have positive impact on public investment, whereas farm subsidies crowd out public investment as indicated by negative relationship between farm subsidies and public investment.

4.3 The theory of private investment could be straight forward, if prospective profitability of investment (i.e., expected rate of return on investment) is known, but uncertainties about the expected returns due to yield and price risks, and low risk-bearing ability of farmers would make the decision-making by farmers on investment very complicated. Any study of farmer's investment behaviour has to be carried out in a multivariate simultaneous equation framework, with appropriate price and non-price determinants as explanatory variables and with proper lag structure for each explanatory variable. For this reason, the empirical studies on private investment function in agriculture

have come out with variety in modelling the relationships. In the absence of a well designed theory of private investment on agriculture, one may have to turn to empirical studies to gain insights into the determinants of private investment.

- 4.3.1 Various empirical studies on private investment have identified price factors like terms of trade, farm interest rate, farm wage rate, and non-price factors like technology, institutions (ex. Institutional credit, land and tenancy reforms, etc.) infrastructural investment like rural roads and electrification by public sector, other public sector investment items like watershed development programme, irrigation works, regulated markets, etc., value of agricultural output, allocative preference of farmers for investment, and private capital stock in the preceding year as determinants of private investment. Choice of explanatory variables and their measurement, and the choice of equations for estimation, and data period would have primary bearing on the direction and magnitude of elasticity of private investment with respect to explanatory variables.
- 4.3.2 To illustrate the argument preceded, citation of the ways in which researchers have modelled their studies would be in order. For example, Chand (2000) in his study on determinants of private investment during 1980/81 to 1996/97 has concluded that terms of trade for agriculture and institutional credit to farmers have positive and significant impact on private capital formation at national level, but public sector investment (based both on CSO investment series and broad investment series) did not have positive impact on private investment at national level. However, state level study by pooling data of 16 major states has led to the inference that both public investment and institutional credit have exerted a positive significant impact on private capital formation in agriculture. Here again, the public sector capital expenditure of 16 major States, though positive in its impact on private investment, is found not to have significant impact during the year 1990/91. In a recent study by Chand and Parmod Kumar (2004), rate of return to private investment which in turn depends on terms of trade and technology, is found to be the most important determinant of private capital formation. The second most important determinant of private investment is the addition of new farm holdings. Institutional credit and subsidies are found to have positive impact on private capital formation. There is asymmetry in the impact of increasing and decreasing public investment on private investment. An increase in public investment definitely impacts positively private investment, while decline in public investment forces farmers to cope with the adverse impact of decreased public investment by increasing private investment.
- 4.3.3 In yet another study using the data of 17 major states from 1970/71 to 1998/99 and using simultaneous equation model, Roy (2001) has attempted to explain variations in private investment in agriculture. This study has identified public investment (as per broad series), terms of trade, rural road density, and per hectare subsidy as the major determinants of private investment with positive impact. The positive impact of subsidy on private investment runs against the well-articulated stand that agricultural subsidies in general are bad, and that they would reduce public investment. It is not clear whether this positive gain in private investment due to subsidy would compensate the loss due to decreased public investment. The incidence of rural poverty is also found to have negative impact on private capital formation. Further, the negative and significant impact of percentage area under marginal holdings is suggestive of land holding size constraint on investment on farm assets, and it is also suggestive of the need for more public investment in agriculture to support and sustain the viability of marginal holdings.
- 4.3.4 Another approach to identification of determinants of public investment could be to measure public investment in terms of both physical and financial terms with appropriate lags to impact private investment, institutional credit and index of terms of trade (lag one year), and to perform the analysis in a multiple regression framework. A recent study (Gulati and Bathla, 2002), using data for the years 1980/81 to 1998/99 has inferred that public sector investment in agriculture (represented by canal

irrigation and power supplies to agriculture in cumulative form), terms of trade and institutional credit have positive influence (inducement effect) on private investment. It is also argued that any neglect of these variables in Government investment programmes would have an adverse impact on private sector investment and agricultural growth.

4.3.5 Different studies, conducted with data set for different periods, have not merely identified different determinants of private investment, but also have indicated varying importance of the same determinants in influencing private investment. The signs and the sizes of determinants appear to hinge on period of study, choice and measurement of variables, and choice of estimation equation. Most of the studies have concluded that public investment is an important determinant of private investment whether termed as complementarity effect or inducement effect. Perhaps the magnitude of the influence of public investment on private investment may vary depending on model specification, period of analysis, stage of technological and agricultural development and policy environment. However, there is some validity in the argument that if public investment on all major heads (as per broad investment series) are taken into consideration in the measurement of public sector investment variable and if appropriate lags are incorporated (to account for response of private investment to public investment), then the public investment tends to have a strong impact on private investment. Perhaps all kinds of public investment may not impact private investment. The issue of which public investments induce more private investment, which ones reduce private investment, and which of private investments are unaffected by private investment is still a matter of research interest, and the results from which will be quite valuable in policy making on public investment resource allocation. The impact of public investment on private investment is still debated, and that forms the theme for the next section.

#### 5.0 Debate on Complementarity between Public and Private Investment in Agriculture

It is recalled from Section 3.0 that all India trend analysis of real public and private capital formation indicates the movement of both investment series in the same direction between 1960s and mid 1980s, and a divergent movement of these series since mid 1980s with public sector investment falling and that of private sector rising steadily. This decline in the momentum of public sector investment was considered as a disquieting development in India. It is also recalled from section 5.0 that public investment is one of the major determinants of private investment,. And any neglect of public investment in resource allocation by both central and State Governments would adversely affect agricultural growth and policy concerns like poverty alleviation. Even though positive impact of public sector investment on private sector investment has been established in a multivariate framework, the relationship between public and private sector investment has become a matter of great debate with its implications for policy directions so as to influence capital formation in Indian agriculture. The argument has been sharpened by the studies by Rath (1989); Shetty (1990); Gandhi (1990 & 1996); Rao (1994 and 1997) and Dhawan (1996 and 1998); Krishnamurthy and Pandit (1994); Storm (1993); Mitra (1996); Misra and Hazell (1996 and 1998); Mishra and Chand (1995); Chand (2000), Roy (2001); Gulati and Bathla (2002) and Chand and Parmod Kumar (2004). An examination of these studies would lead to five major inferences.

- There is a crowding in or positive inducement effect of public investment on private investment due to strong complementarity between public and private investment.
- There is only weak complementarity between these two types of investment.
- There is a strong relationship between two types of investment at micro level like canal-irrigated areas. Complementarity at macro level may not show up due to aggregation problem of treating all public investments alike with respect to impact.

- There is no apparent complementarity. Private investment may be partly induced by public investment and partly autonomous.
- State level analysis of trends and proper definition and measurement of public investment variables support a strong case for complementarity both at national and state level.

5.1 Given these influences drawn by different researchers, the estimated elasticities of private investment with respect to public investment have turned out to be different. For example, in some earlier studies the value of elasticity coefficient is found to be 0.62 in a study by Chakravarthy (1987) for the period 1970/71 to 1982/83, 0.66 in a study by Shetty (1990) for the period 1960/61 to 1986/87, 0.66 by storm (1993), 0.98 by K.Krishnamurthy and Pandit (1994), 0.25 by Dhawan (January-June, 1996) with respect to canal irrigation ratio (treated as a proxy for public investment), -0.50 by Mishra and Chand (1995), 1.55 for the period 1960-70, 0.69 for the period 1970-80 and -0.31 for the period 1980-90 by Misra and Hazell (1996), and 0.50 Saibaba (1996).

Differences in inferences derived on complementarity between public and private investment and in the estimated elasticities of private investment with respect to public investment could be attributed to many reasons such as different data sets used, data period, failure to see differences between instantaneous and cumulative effects of public investment on private investment, different lag structures used to find out the response of private sector investment to public sector investment, use of different terminologies such as complementarity, inducement effect and crowding in/out effects, failure to include relevant variables to assess the net effect of public investment, failure to recognize lagged response from farmers and lagged impact of public investment, failure to differentiate between movement of trend series and causal relationships, use of physical and financial variables, different evidences from macro and micro level studies, and treating public investment in irrigation on par with other variables like investment in roads.

5.2 With all the differences in inferences derived and elasticities estimated, the debate has been quite useful to understand and unearth the complexities of relationship between public and private investment. A brief presentation of methodologies and results of a few studies would illustrate the nature of the controversy and complexity in confirming or rejecting complementarity hypothesis.

5.2.1 Based on increasing trend in the CSO estimates of both private and public investment in Indian agriculture till 1980/81, there are many studies, which have confirmed the proposition on complementarity. The studies by Chakravarthy (1987), Rath (1989), Shetty (1990), Storm (1993), Rao (1994 and 1997), Krishnamurthy and Pandit (1995), Gandhi (1990 and 1996), Dhawan (1996 and 1998) have confirmed complementarity between public and private investment. Arguments of some of these studies could be placed in the proper perspective. Rao (1994 and 1997), while confirming the complementarity proposition, has argued that if public investment made in agriculture are properly accounted for including the excluded items like rural electrification, rural roads, storage, etc. The complementarity between public and private investments stands out prominently. Dhawan (1996 and 1998), another supporter of complementarity proposition, has treated public canal irrigation intensity as a relevant explanatory variable instead of total public investment in agriculture for explaining variations in private investment. The rationale is that public canal irrigation accounts for a major share of total public investment in agriculture. Hence the positive and significant impact of canal irrigation intensity on private investment both with macro and micro level data establishes the veracity of complementarity hypothesis. Infact macro and micro level evidences are found to lend support the complementarity proposition that public sector investment in canal irrigation stimulates private investment, including private means of irrigation.

- 5.2.2 The distinct trends have been observed with CSO data upto the end of 1980's. First the movement of investment series of both public and private sector till 1990/81 has led to the emergence of complementarity proposition. Second, after 1980/81 both the series started moving in opposite direction (declining trend in public sector investment, but continuous increase in private investment). This movement of both the investment series in the opposite direction has been the basis for questioning the validity of complementarity hypothesis by Chand and Mishra (1995). Yet another line of argument has been that though aggregate series of public and private investment do not support the complementarity hypothesis, project specific, public sector investment, especially in irrigation, induced the investment in agriculture on private account (Mitra, 1996). This partial acceptance of complementarity proposition gives credence to the argument that complementarity hypothesis should be tested at the level of investment projects, and could be more prominent in the construction of assets like irrigation.
- 5.2.3 A redefinition and re-estimation of public investment in agriculture (broad invest series) has led to conflicting/confirming inferences on complementarity issue. For example, Chand (2000) has found negative and non-significant impact of public sector investment on private investment. This result is suggestive of lack of complementarity. But Chand (2000), using State level cross section study for the year 1981/82 to 1991/92, has led to the inference that broad public investment series bears a positive and significant impact on private investment in 1981/82, and positive but insignificant impact in 1991/92. So his State level study with broad investment series suggests the conclusion that there is a partial complementarity depending on the type of public investment in different regional settings. Yet in a recent study by Chand and Parmod Kumar (2004), it has been established (as discussed under Section 4.32) that there is asymmetry in the impact of public investment on private investment. An increase in public investment is found to have positive impact on private investment, but a decline in public investment is found to have increased private investment as a part of coping strategies of private investors.
- 5.2.4 Redefinition and re-estimation of public investment data to derive broad investment series, and appropriate measurement of investment components, appropriate lags incorporated (to account for response of private investment to public investment), and the modelling of relationship between public and private sector investment in a simultaneous equation framework may lead to different conclusion. Roy (2001), using this methodological structure has derived the inference that public investment has a strong impact on private investment, and there is a strong case for complementarity proposition at national and State level. Yet in a recent study by Chand and Parmod Kumar (2004), it has been established (as discussed under section 4.3.2), that there is asymmetry in the impact of public investment on private investment. An increase in public investment is found to have positive impact on private investment, but a decline in public investment is found to have increased private investment as a part of coping strategies of private investors.
- 5.2.5 It is recalled from section 4.0 that irrigation accounts for more than 90 per cent of public sector investment in agriculture. Further, public sector investment in power sector is required for pumping water. But these items of capital expenditures have a long gestation period of public investment in these two sectors. Hence, it is not rationale to visualize a strong complementarity. Further, the farmers' response to public sector investment in irrigation and power supplies cannot be instantaneous, and it is likely to be stretched over years. Hence expecting strict complementarity in such a situation is not warranted. There are two options to measure public sector investment in these two areas for testing complementarity hypothesis. First, one could use quantity of water and power supplied to agriculture each year. But it is difficult to get data on water supplied each year under can irrigation system. Second, in the absence of easy availability water supplied each year, one could use cumulative potential created as a proxy variable for the total water supplied. Hence, it

is rational to use physical quantity of power supplied to agriculture each year, and cumulated potential of canal irrigation created, and the annual expenditure incurred in public sector under 11 heads (Gulati and Bathla, 2002) to test the impact of public investment on private investment in agriculture. Measurement of cumulative investment in canal irrigation could be both in physical and financial terms. Gulati and Bathla (2002) have performed this kind of analysis, using data from 1980/81 to 1998/99, and concluded that it is hard to reconcile with the argument of no inducement effect or weak complementarity between public and private investments as stated by Chand (2000) and others. The analysis performed by Gulati and Bathla (2002) has led to the inference that there is a significant positive impact of public investment (if properly measured and lagged) on private investment, whether the public investment is measured in physical or financial terms.

- 5.2.6 Summing the results on complementarity hypothesis, there appears to be more evidence to confirm the complementarity hypothesis without ignoring other determinants of private investment. However, the magnitude of elasticity of private investment with public investment is bound to vary with the period of study, choice of variables on public sector investment and their measurement, construction of appropriate lags to impact and to respond, and specification of structural equations. Further, it is equally important to recognize that all kinds of public investment may not induce private investment.

While arguing with narrow data set that private sector investment may increase even under the situation of declining public sector investment, one has to keep in view the compositional differences as between public and private sector investment, and the difference in their investment objective function. Public sector investment portfolio is expected to be a part of broader development agenda like equity, conservation of environment, and poverty alleviation, enhancing competitive capacity of Indian agriculture both in domestic and international markets, and the like. The enabling investments in rural link roads, big irrigation projects, rural power supply, storage structures and market yards may have to be handled under public sector investment to induce private sector investment. Any entry of corporate sector to these lines of investment to induce farm household sector investment may be unimaginable for the time being, and certain types of public sector investments are necessary even to induce corporate sector to invest for agriculture. Hence, the challenge is to identify the sectors/areas where public sector investment is likely to have strong complementarity, weak complementarity, and where there is lack of complementarity, so as to decide public investment portfolio. All kinds of public investment may not induce private investment, of both household and private corporate sector. Hence from the viewpoint of long term agricultural growth, lack of complementarity or weak complementarity should not under-estimate the importance of public sector investment. The challenge lies in identifying right priorities for public investment by keeping in view the varying priorities depending on stage of agricultural growth/development, broader development agenda, and more inducement effect on private farm household and private corporate sector investment.

- 6.0 State-wise Analysis of Investment Intensity and Investment Growth

Three approaches are followed to analyze the investment intensity of different States. First, capital expenditure per hectare of net sown area (NSA) at constant prices could be analyzed across States. This could be coupled with trend rate (%) of growth analysis for the same States. Second, both public and private investment intensity of States could be analyzed, along with investment growth rate (%) of public and private sector. Third, analysis of public private sector investment as a per cent of AGDP could be yet another way of examining investment intensity across States.

- 6.1 Table-6.1 provides State-wise statistical profile with respect to capital expenditure per hectare and trend rate of growth across States during the period 1974-75 to 1996-97.

- With respect to 17 major States, only six States (Jammu & Kashmir, Punjab, Maharashtra, Himachal Pradesh, Uttar Pradesh and Kerala) are found to have registered above national average (Rs.239) of per hectare capital expenditure per annum. In fact, Madhya Pradesh, Rajasthan and Tamil Nadu had experienced per hectare capital expenditure intensity of less than Rs.100/ha/annum.
- The small sized North Eastern States and Goa are found to have recorded far above the national average. The range is between Rs.500 per hectare (Meghalaya) to Rs.1554 (Gao). The notion that North Eastern States have not been given adequate importance in development resource allocation stands dispelled at least with respect to agricultural sector. There may be other development issues.
- For the country as a whole, the trend rate of growth of capital expenditure per hectare was negative (-3.16) during the study period. All the 17 major States had experienced negative growth rates of capital expenditure. The States with high negative growth rates (over 2.5%) are Punjab, Bihar, West Bengal, Tamil Nadu, Himachal Pradesh, Madhya Pradesh, Orissa and Uttar Pradesh.
- In case of smaller States, only Nagaland, Goa and Manipur are found to have experienced negative growth rates of capital expenditure.

6.2 Table-3.15 presents an analysis of public and private sector investment intensity across States as well as investment growth rates of public and private sector.

- Based on investment intensity (Rs./ha), the States could be clustered into four groups:

High public and low private investment: Assam, Jammu & Kashmir, Orissa and Northeastern States
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Low public and high private investment: Haryana, Karnataka, Madhya Pradesh, Rajasthan and Tamil Nadu
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High public and high private investment: Uttar Pradesh, Punjab, Maharashtra, Kerala and Himachal Pradesh
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Low public and low private investment: Andhra Pradesh, Bihar, Gujarat and West Bengal
--

- Based on investment growth rates in public and private sectors, the states could also be clustered in four typologies:

High public and low private investment growth: - None -
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Low public and high private investment growth: Andhra Pradesh, Gujarat, Himachal Pradesh, Jammu & Kashmir, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, North Eastern states and All India
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<p>High public and high private investment growth: Haryana, Karnataka and Punjab</p>
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<p>Low public and low private investment growth: Assam, Bihar, Orissa and West Bengal</p>
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One major observation could be made on the results presented in Table 6.1 and 6.2.

- The clusters developed from the results of both the tables do not tally converge, because the results of Table 6.1 would provide insights into intensity of public and private investment in average terms per annum, whereas Table 6.2 provides results on estimated investment growth rates between 1987-1999

6.3 Yet another way of examining investment intensity across the States is to examine public and private investments as per cent of AGDP. Table 6.3 would provide results on this issue:

<p>High public and low private investment: Jammu &amp; Kashmir, Orissa and North Eastern States</p>
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<p>Low public and high private investment: Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Punjab, Rajasthan and Tamil Nadu</p>
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<p>High public and high private investment Andhra Pradesh, Gujarat, Maharashtra and Uttar Pradesh</p>
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<p>Low public and low private investment Assam, Bihar and West Bengal</p>
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7.0 Trends in Capital use Efficiency

It is realized that it is not enough to analyze only trends in the level of investment, but it is equally important to assess efficiency of investment made. Efficiency of investment is usually assessed by Incremental capital Output Ratio (ICOR) and the inverse of that being Marginal Efficiency of Investment (MEI). ICOR is both a measure of capital intensity and measure of efficiency in its use. It is a useful device for determining sectoral allocation of capital resources, and also to estimate the level of investment required to achieve a targeted output level and growth. Further, it could also be used for deriving output growth rate, once capital resource position is known.

7.1 A review of estimates on ICOR and MEI is suggestive of variations across estimates derived, depending mainly on choice of time period, deflator base year, and the choice of time lag used for determining the flow of capital services. The estimates (Table-7.1) of ICOR by Misra and Hazell (1996) for the period 1952/53 to 1991/92 are suggestive of improved efficiency of capital use in Indian agriculture during late 1980s, as ICOR decreased from 4.37 to 3.32 during the 1978/79 to 1986/87 to

1987/88 to 1991/92. This is also reflected in the increased MEI during late 1980s. This improved efficiency could be partly due to increased private investment during late 1980s, and also to enhanced use of yield increasing inputs and improved market support.

- 7.2 Chand (2000) has estimated (Table-7.2) ICOR for a period of 20 years from 1974/75 to 1994/95, using both the CSO investment series and broad investment series developed by him. Three major observations could be made on these estimates. First, during the first two periods of study, there was a considerable difference in ICOR as well as MEI based on CSO and broad series for the obvious reason of same value of incremental output used in case of both the series, whereas the incremental total capital in case of broad series was considerably higher than the one computed with CSO series. Second, the ICOR based on broad series declined sharply with effect from II period, and the difference in ICOR narrowed down over time. Third, compared to period I, there was an improvement in the capital efficiency in agriculture as reflected in MEI of both CSO and broad series, even through symptoms of marginal deterioration in efficiency is observed for IV period compared to III period. However, a broad conclusion that could be drawn from the analysis is that there has been an improvement in capital use efficiency in Indian agriculture since the beginning of 1980s.
- 7.3 The study by Roy (2001), using data for the period of 1969/70 to 1996/67, has indicated that the lowest ICOR was found in case of Fourth plan period (1969/74). Even though it increased during Fifth Plan period, it started declining after and got reverted to fourth plan level by the end of Eighth plan. The possible reasons for the lowest level of ICOR (or the highest level of capital use efficiency) during the Fourth plan period could be attributed to impressive output growth during the first phase of green revolution, and the increased flow of services from capital investments made on major irrigation projects. The study has also indicated, barring variations in ICOR across States, most of the States have experienced an improvement in efficiency of capital use in agriculture.
- 7.4 In yet another recent study, Gulati and Bathla (2002) have estimated ICOR and MEI (Table-7.3) at 1993-94 prices. Since ICORs varies annually mainly due to fluctuations in output, ICOR is estimated on the basis of three yearly moving averages of GDPA and GFCFA. The pattern of behaviour of ICOR over the Five year plan periods (Fourth plan to Eighth plan) suggests an improvement in the efficiency of investment in agriculture from Fourth plan period to Eighth plan period, with some variations in between. The MEI, which was 0.207 during Fourth plan period increased to 0.511 during Eighth plan. This improvement in capital use efficiency is found to have taken place, even though there was a reduction in the ratio of GFCF in agriculture to incremental GDPA from 7.58 in mid eighties to 6.56 in mid nineties.
- 7.5 An examination of State-wise analysis of ICOR in agriculture during 1992/97 (Table-7.4) suggests the following broad inference:
- Barring a few States, the values of ICOR are found to be quite low in Eastern and Southern States as compared to Northern States. Perhaps this could be attributed to less capital intensive agricultural production system and to efficient use of capital resources in these two groups of States.
- 7.6 One broad observation that would follow from all these analysis is that there has been visible improvement in capital use efficiency in agriculture. Further, the state level analyses of ICORs are suggestive of variations in these values across states. The question that needs examination is whether the use of one value of ICOR for all states in resource allocation for agriculture is appropriate and does it not alter the normative allocation of resources for agriculture across states. Yet another issue is that planning commission has been using much lower ICOR estimates (used ICOR of 2.3 during Eighth plan and 2.2 during Ninth plan). As a result, the sectoral allocations

of investment resources for agriculture are under estimated, given the targeted output growth rate. More on this later.

#### 8.0 Capital Formation and Agricultural Growth

The positive association between capital formation and agricultural productivity as well as agricultural output growth is understandable. But there are various methodological issues surrounding this association, when causal relationships between them are to be established along with other relevant variables. First, capital investment is a determinant of agricultural growth, but agricultural growth could also be a determinant of capital investment, particularly in case of private investment. Second, the impact of total investment on growth could be different from that of public and private investment separately. Third, two alternative measures of public investment viz, physical and financial terms may give rise to different productivity and output elasticities. Fourth, there are differences in the choice of public capital expenditure heads (recall narrow and broad public investment series) to assess the impact. Choice of capital expenditures may be in the form of index of agricultural infrastructure, index of transport and communication, research, extension and educational infrastructure, credit infrastructure, and various other definitions and measurement of investment variable. Fifth, the time lag allowed for investment and productivity/output response is yet another methodological issue. Sixth, choice of single equation model as against simultaneous equation model may give rise to bias in the assessment of impact of investment on productivity and output growth/deceleration.

8.1 With all these methodological complexities, the volume and composition of agricultural investment has turned out to be one of the major determinants of agricultural productivity and output growth, and it is an important instrument to raise the level of agricultural productivity and output growth, and through this growth the effect on poverty alleviation. The major results derived by Chand (2000) from his study covering the period 1974/75 to 1996/97 deserve careful consideration. First, both the public and private investments independently are found to have positive impact on agricultural productivity and output growth. Even though the impact of public investment alone is found to be positive but non-significant statistically, the impact of total investment is found to be positive and statistically significant on both productivity and output growth. Second, even though public investment as a determinant of private investment is found to be less important than terms of trade and flow of institutional credit, importance of public investment to create infrastructure and to promote long term agricultural growth should not be undermined. This supports the need for reversing the declining trend in public sector investment in agriculture, of course to be accompanied by measures to improve the efficiency of public investment. More on this later.

8.2. A simultaneous equation model has been employed by Roy (2001) to derive both agricultural productivity equation (to identify the determinants of agricultural productivity) and rural poverty equation (to identify determinants of rural poverty). The analysis has estimated the effects of various economic, agro-climatic and institutional variables on agricultural investment, productivity and rural poverty. With respect to the relationship between agricultural productivity and investment, and between agricultural productivity and other explanatory variables, certain useful results to provide direction for policy reform could be sorted out. First, the impact of per hectare investment on per hectare agriculture GDP is found to be positive and statistically significant. Though agricultural GDP and its growth did not decline as predicted during the later part of 1980s following decline in public investment, there is no disagreement about the importance of public investment for long run output growth. Second the impact of rural literacy, proportion of area under marginal holdings, per hectare storage capacity, cropping intensity, agricultural subsidy, terms of trade, per hectare institutional credit and rainfall on agricultural productivity are found to be both positive and statistically significant. The impact of cropping intensity

captures the effect of irrigation and seed-fertilizer technology, and estimated productivity model does not include rural market and electricity consumption because of multi-collinearity problem with storage and rural literacy rates. Third, instability in Government expenditure on agriculture is found to be inversely related to the growth in agricultural sector. More on the policy implications of these results later.

- 8.3. In yet another important research study by Gulati and Bathla (2002), the relationship between investment in agriculture and GDPA has been explored, using data for the period 1980/81 to 1998/99 at 1993/94 prices. With GDPA as a dependent variables viz., cumulative public and private investment, terms of trade and gross cropped area (GCA) are included in the structural system of equations. The impact of factors such as rainfall and technology (measured in terms of fertilizer use intensity/area under high yield varieties) on agricultural output growth is very well recognized. The analysis with simultaneous equation model in reduced form has provided a major useful inference. Whatever the concept of public investment used (concepts I, II and III as discussed under section 2.4), public investment (measured both in physical and financial terms) is found to have positive significant direct impact on GDPA and indirect impact through its inducement effect on private investment in agriculture. Hence, decline in public investment in agriculture would affect agricultural output growth through both direct and induced effects. Further, the positive and significant impact of terms of trade and GCA on agricultural output growth is also evidenced with the analysis. More on the policy implications of these later.
- 8.4. The relationship between agricultural productivity and infrastructure variables such as transport, power, irrigation, credit, marketing, research, extension, fertilizer, tractor, communication, education and health has been identified by Thorat and Sirohi (2003). Among various infrastructure variables, irrigation, power, research and transport are found to have a great influence on agricultural productivity and output growth. Hence, public investment impacts agricultural productivity/production directly and through its inducement effect on private sector investment in agriculture is very well established.
- 8.5. A recent study (Chand, 2004) has attempted to establish the relative importance of public sector investment in agriculture and subsidies in influencing AGDP, among other determinants of AGDP such as terms of trade, net sown area and rainfall. Instant return to one rupee public expenditure on subsidies is found to be much higher (Rs.3.19) than the impact of one rupee increase in capital stocks on AGDP (0.61). But this is the impact of only one year. But, if one year impact of capital stock on AGDP is multiplied by the expected life of capital stock, that total impact has turned out to be more than double the impact of subsidies. In view of this trade-off in public resource allocation between subsidies and public capital investment, the diversion of public resources from subsidies to public investment is suggested. More on this under section-9.
- 8.6. With all the methodological complexities related to the choice of data set on investment and the measurement of investment, choice of explanatory variables to account for variations in agricultural productivity/production, and the choice of statistical models, a few inferences on the relationship between capital formation and agricultural growth would follow. First, capital formation in/for agriculture has positive impact on agricultural productivity and output growth. Second, other variables like terms of trade and technology are found to have positive impact on productivity and output growth in agricultural sector. Third, public sector investment becomes a crucial factor to impact the growth of agricultural sector, both because of its direct and inducement effects. Fourth, the impact of public investment on AGDP is found to be more than double the impact of subsidies. Fifth, any policy failure to reverse the declining trend in public sector investment would adversely affect the growth in agricultural sector, which in turn would affect adversely the growth of non-agricultural sector and thereby the growth of general GDP through both supply and demand linkage of agricultural sector with non-agricultural sector.

## 9.0 Main Inferences and Policy Directions

Policy directions/reforms aiming at public investment, private corporate investment, and private farm household invest in agriculture are derived from the major inferences arrived at with the analysis. The focus of the present study has been to analyze/examine investment growth cycle, compositional shifts in capital formation in/for agriculture, investment behaviour of public and private sector, debate on complementarity hypothesis, State-wise disparities in investment intensity, capital use efficiency, and capital formation and agricultural growth.

### 9.1 Main Inferences

#### A. The Investment Growth Cycle

- The investment growth cycle has been analyzed from different angles like growth rate trends in agriculture GFCF vis-à-vis aggregate GFCF, shifting shares of aggregate GFCF and of agriculture GFCF in GDP, shifting share of agriculture GFCF in AGDP, and trends in the annual growth rates of public and private investment in agriculture in relation to trends in overall investment growth.
- The investment growth cycle in Indian agriculture encompasses rising trend, subdued phase, peak phase, persistent deceleration, and only marginal recovery. The persistent loss of momentum is considered as a disquieting development, with implications for broader development agenda.
- The percentage of agricultural GFCF in total GFCF had halved between 1960s and 1990s.
- Public sector investment growth rates were quite high during 1970s, became negative during 1980s, and there has been only a marginal recovery in 1990s. The respectable growth rate in private sector could not compensate the decelerating trend in public sector investment, leading to a total loss of momentum, leading to a total loss of momentum in total GFCF (in real terms) in agriculture. Growth cycle analysis with broad investment series has confirmed deceleration in public investment both at national and State level.
- In case of aggregate GCF as well as AGCF, the positive changes were greater during post-reform decade than during pre-reform decade, and the rates of change were greater in case of aggregate GCF than in case of AGCF. Further, decline in the percentage share of public sector in AGCF was greater during pre-reform period, and obviously the increase in the share of private sector was more during pre-reform period.

#### B. Compositional Shifts in Capital Formation

- During early years of the period 1960/61 to 1998/99, the share of public and private sector investments in total investment in agriculture was almost equal, and there has been a steady decline in the share of public investment from 46% in 1960/61 to 24% in 2002-03, leading to an increased share of private investment.
- Since irrigation is the dominant item of capital expenditure under public investment, any decline in public investment refers basically to declining public investment in major and medium irrigation schemes.
- Out of total public investment (as per broad investment series), investment in irrigation schemes, and food and storage would form around 65%. The rural development programmes have experienced a considerable hike from about 10% of total public investment in agriculture to about 24% over a period of time. But crop husbandry, fertilizer industry, and cooperation are found to have experienced decline in their share.

- Agricultural implements/ equipment/machinery, and well/other irrigation structures continue to be dominant in investment portfolio of farm households both at national and State level. Perhaps, with structural transformation in agricultural sector accelerated, the share of capital expenditure on land improvement, orchards and plantations and dairy sheds may tend to increase.

#### C. Investment Behaviour of Public and Private Sector

- Investment behaviour of public sector is found to be governed by food situation of the country, agricultural development policies of the time, and by political economy compulsions. Public sector investment has become a residual claimant under political economy compulsions such as subsidies.
- The investment behaviour of private sector is found to be governed by both price subsidy, and non-price variables, such as public investment, terms of trade, technology, flow of institutional credit, and other institutional variables like rural literacy and land ownership patterns.

#### D. Debate on Complementarity Hypothesis

- The debate on complementarity hypothesis has led to different conclusions such as there is a strong complementarity, weak complementarity, and there is no complementarity. Elasticity of private investment with respect to public investment has turned out to be different in different studies. But different conclusions and elasticities are mainly due to definition and measurement of public investment, data period, choice of independent variables, construction of appropriate lags to impact and to respond, and specification of structural equations. With all these methodological complexities, there appears to be more evidence to confirm complementarity hypothesis without ignoring other determinants of private investment. Yet, the element of asymmetry in respect of the relationship between public and private investment has some implications for policy. An increase in public investment is found to have positive impact on private investment, while decline in public investment forces farmers to cope with the adverse impact of decreased public investment by increasing private investment.

- E. State-wise analysis of investment intensity and investment growth is suggestive of regional disparities. These are States with low investment intensity, low public and private investment per hectare, low public and low private investment growth rates, and low public and low private investment as a per cent of AGDP. There are also States with high public and low private investment, high public and private investment and those with low public and high private investment. Different policy regimes may have to be designed accordingly. More on this under Section-9.

#### F. Capital Use Efficiency

- The analysis of trends in both ICOR and MEI estimates are suggestive of the conclusion that there has been some improvement in capital use efficiency in Indian agriculture. But there are two concerns, which need attention. First, normative allocation of resources by Central Government to different States does not get implemented when the same ICOR is used across different States. There are considerable variations in ICORs across States. Second, since the Planning Commission has been using much lower ICOR estimates, the sectoral allocation of investment resources to agricultural sector are underestimated, with implications for the achievement of targetted output growth in agricultural sector.

#### G. Capital Formation and Agricultural Growth

With all the methodological complexities in sorting out the net effect of capital formation on agricultural productivity and output growth, some major conclusions on this relationship have been drawn. First, capital formation in/for agriculture

has positive impact on agricultural productivity and output growth. Second, other variables like terms of trade, technology, institutional credit, and host of other institutional and agro-climatic factors are found to have impacted productivity and output growth. Third, public investment impacts agricultural productivity/production directly, and through its inducement effect on private sector investment. There is a need for recognizing the relative importance of public investment and subsidies in impacting AGDP. The total impact of public investment on AGDP is found to be more than double the impact of subsidies. This supports the need for reverting the declining trend in public sector investment and for accelerating (through inducement effect) private sector investment. Fourth, any failure in policy front to revert the declining trend in public sector investment would adversely affect the growth of agricultural sector, which in turn would affect the performance of non-agricultural sector and realization of other broader development policy goals.

## 9.2 Policy Directions and Reform Agenda

Placing a few aspects in order, before the specifics of policy directions and reform agenda for capital formation in agriculture are indicated. First, the share of agriculture in aggregate GFCF has declined over a time. But investment in agriculture is one of the major engines of productivity and production growth in the sector. Hence, over 4% growth in agricultural sector is contingent upon level and composition of investment.

To achieve the growth target of 4.5% in agriculture, the investment should grow at an annual rate of about 12%, as compared to the present level of about 5%. Thus the investments requirement in agriculture is much higher than the one estimated by the Planning Commission on the basis of its much lower estimates of ICOR. Any short-fall in the investment growth will result in lower agricultural growth, which may have major adverse consequences on the overall growth of the economy (through inter sectoral supply and demand linkages), and on the realization of broader development agenda. Hence a big push in investment in agricultural sector is required. Second, since level of public investment is an important determinant of private investment through complementary/inducement effect, the choice of public sector investment portfolio is crucial. It impacts growth of agricultural GDP directly as well as indirectly through its inducement effect on private investment. Third, public investment has to be considered as a policy instrument for reducing regional agricultural development disparities and for realizing broader development agenda. Fourth, demand for food items such as fruits, vegetables, fats and livestock products is growing both in the domestic and international market. This demand diversification provides market signals for crop/enterprise diversification in the agricultural sector. This in turn would place new pressures on agricultural policy including policies for augmenting the level of investment as well as its composition. Any demand-induced diversification would place new demands on market infrastructure (like more investment on cold storage, rural roads, communication, marketing network, etc.) and institutions. Infact, price-induced crop diversification is not sustainable in the absence of back up from non-price factors such as technology, irrigation and rural infrastructure. Fifth, any effort to make Indian agriculture globally competitive needs the support of agriculture R & D for yield-augmentation, unit-cost reduction and quality augmentation at farm level, and R & D support for increasing efficiency in taking the produce from the farm gate to the gates of domestic and international markets. Sixth, public-private sector partnership is imperative for augmenting the level of investment in agriculture and for shifting its composition. Seventh, a well-designed policy reform agenda is needed for agricultural investment to get into desirable areas and to have desirable impact.

### 9.2.1 Public Policy Reform Agenda and Public Investment

- There are many directions in which policy reforms are required for investment in agriculture to be effective and efficient:
  - ✓ It has been recognized that the scope, instruments and institutions of agricultural price policy should be reviewed critically due to transition from protective to competitive agriculture regime. In this context, long term return from public investment is found to be more than double the rate of return from subsidies. Gradual withdrawal of subsidies especially for irrigation water, electricity, fertilizer, and pesticides would provide a large pool of resources with which to compensate producers for price policy reform through higher return investments such as technology, infrastructure and institutions. These investments will have positive impact both on farm household and corporate investment. Infact our policy failure is reflected in much larger emphasis on prices than on non-price productivity augmenting factors (Vyas, 2004). Other policy instruments like targeted food distribution and sound crop insurance may provide income support with lower cost and less market distortions.
  - ✓ The removal of restraints on export is an important step in reducing the traditional implicit tax of the agricultural sector. The removal of such export restraints can promote private investment and employment in the supply chain for internationally competitive commodities.
  - ✓ Import liberalization and domestic deregulation have benefited many industries and consumers during reform regime. Whether this kind of liberalization and deregulation would also benefit the growth of agricultural sector is an issue that needs to be addressed in the perspective of transitional costs to farmers.
  - ✓ Since institutional credit is found to have positive impact on private capital formation, the need for reform in agriculture credit policy is imperative. Policy reforms to encourage SHGs to borrow micro finance for micro-enterprises, scaling up the coverage of NABARD policy to provide credit for States so as to support their capital development activities in the area of soil conservation, rural market yards, inland water ways, cold storage, godowns, mini-hydel plants, etc., provision for States to borrow from RIDF for meeting States' share for recapitalization of cooperative banks, scaling up the provision of credit for small/marginal/tenant farmers for buying land and for acquiring non-land assets, and flow of more institutional credit to low investment States like eastern States are needed to create a favourable policy environment for farmers as well as for corporate sector.
- Private investment cannot be always a substitute for public investment, mainly because of differences in their investment portfolio. Public investment is more of a complement to private investment. There are areas like watershed, rural roads, rural electrification, large irrigation schemes, agricultural research and extension, markets, which still continue to remain primarily in the public sector domain. Further, stimulating private domestic investment and foreign agri-business investment will require public investment in market infrastructure, comprehensive reforms of market institutions and regulations, and supportive import and export policies. Hence unless adequate investment in rural infrastructure is made by public sector, the strategy of fast-track privatization will not take place.
- There are ample evidences that regional disparities in agricultural development has increased over time (Ahluwalia, 2000 and Kurian, 2000). It is argued that investment in the backward States has greater productivity-enhancement (in the sense of incremental) effect than investment in favoured regions. Added to this, the public investment portfolio could be different for these two types of regions. Private corporate sector may like to branch into favoured regions for making investment. Pro-active role of public sector investment in backward regions for some years to come would not only induce private investment (both of corporate

and household sectors), also contain the problems of development distance between favoured and backward regions.

- It is reported (Roy, B.C., 2001) that compared to northern States, the estimates of ICOR are lower in the Eastern and Southern States. These States would require special consideration for public investment, not only because of their higher capital use efficiency, but also these are the States where majority of our rural poor are concentrated. In States like Himachal Pradesh, Jammu and Kashmir, Madhya Pradesh, Uttar Pradesh, North Eastern States, Assam and Bihar, improvement in capital use efficiency should be the high priority.
- States like Bihar, West Bengal, Assam and Orissa where both public and private investment are low need public policy support for more investment, in addition to measures for increasing the efficiency of capital use.
- Related to this is the use of a single ICOR estimate for the entire country. Obviously, this would alter the normative allocation of resources for agricultural sector across States. Hence, an identification of clusters of States and use of different ICORs for different clusters would perhaps address this issue of normative resource allocation.
- It is argued that reduction in resource flow from centre to States is one of the reasons for decline in investment across States. State Governments should also restrain themselves from diverting resources to subsidize agriculture at the cost of more productive public investment.
- While emphasizing egalitarian distribution of land, two issues need to be addressed. First, the small and marginal holdings need more of public investment support in areas such as community irrigation projects and group marketing of output. In the absence of public investment support, these farmers are likely to face the cost of a transition from protective to competitive agriculture. Second, legal provision may have to be made for leasing in and leasing out land (with retention of their right of ownership) so as to have a reasonable plough unit.
- Development of water resources for agriculture has been mainly in the form of canal irrigation with public investment and private investment in ground water exploitation. The efficiency in the use of canal irrigation is seriously jeopardized due to lack of complementary investment in operations and maintenance. Over exploitation of ground water resources with private investment has given rise to negative externalities. Unless canal irrigation system is operated in partnership mode, and policy is designed to prevent over-exploitation of ground water resources, the orderly harvesting of this key resource will be at stake (Vyas, 2004).

In addition to investment and policy support for sustainable water harvesting for irrigation, investment in land development, by both public and private initiative, should receive serious attention to prevent land degradation and to reclaim the degraded land. The incidence of degradation of natural resources will be much more on backward regions and vulnerable sections of our farmers (Vyas, 2004).

- With the activation of Rural Infrastructure Development Fund, there is an increase in resource availability for public investment. But the challenge is the choice of investment project portfolio for the public sector for efficient utilization of resources under this fund. For example, public investment to encourage food processing/food parks, and production and export of host of horticultural, floricultural, medicinal and aromatic plants.
- It is recalled that public sector investment has been declining since eighties. There has not been much of a response from the domestic private investors to exploit the investment opportunities in infrastructural area created by liberalization. Not much response of FDI has been recorded in this area, even with liberalization of regulations governing FDI. The Planning Commission's

proposal for putting the so called idle foreign exchange reserves (earning extremely low returns) into the area of infrastructure development seems to be an innovative idea. The debate on this proposal is still inconclusive. Could this be done with no increase in fiscal deficit and no monetisation? What kind of infrastructural development such as public goods (e.g., roads), quasi-public goods (e.g., major irrigation, water ways, rural electricity) and private goods (ports, airports) would be appropriate with this fund? With these financial resources, where to mobilize the real resources? Why not depend on Government borrowing, given the fickle nature of foreign exchange reserves? With respect to infrastructural development for agriculture, could this be linked to employment guarantee scheme? What kind of public-private sector partnership, and of professional independent regulatory framework needed for electricity, dams, and canals so as to derive the benefits of a pro-competition infrastructural policy? All these issues need to be addressed before implementing the proposal on foreign exchange reserves for infrastructure development.

- One policy issue that has not received much of attention is substitutability (within some limited range) of institutional transformation for public investment. Both investment and institutional transformation are needed for promoting agricultural growth and for addressing broader development agenda. Institutional transformation can get reflected in social capital formation such as preparing stakeholders for collective management of programmes/participatory management/community management/joint management/decentralized management/indigenous management/user-participation. The concept of social capital can be operationalised with local groups for watershed/ catchment management/ irrigation management/ forest management/ integrated pest management/ micro finance delivery, and by developing information technology to support net works. These local groups, supported by external professionals, could contribute for augmentation of human capital in rural areas for augmenting the productivity of the present level of investment. This could be treated as managerial technology for shifting the production function (of public investment) upward, and unit cost function downward.
- In addition to augmenting public investment in the management of canal irrigation for increasing its efficiency, the public investment in the management of market yards, godowns, cold storage facilities, and the like would form another important priority item of capital maintenance investment. With proper management of these public sector assets, their ICORs could be increased, and with much lower rate of capital investment, the targeted agricultural output growth rate could be achieved. For example, 12.6% growth in investment is required (as against the current rate of about 5%) at ICOR of 3.66 to achieve the targeted output growth rate of 4.5%. Improved efficiency of capital use in agriculture is ensured (say through proper input-pricing and operation of public capital assets in partnership mode), the investment growth rate of 7.91% is enough at ICOR of 3.00 to attain the targeted output growth rate.
- Given the positive impact of primary education on agricultural productivity and poverty-alleviation, public investment on this human capital augmentation needs special consideration.

In view of the above, there is no basis for complacency about the role of public investment in agriculture, which is vital for inducing private investment, and in fact for horizontal spread of benefits of economic reforms. The Structural Adjustment Programme prescribing lower public expenditure and reduction in the development role of the State assumes that private investment will rise when public investment declines (i.e., crowding out/in effects). Even, if this assumption is valid, the private investment will be directed towards immediate private profitability. The larger development agenda is not expected to be addressed by private sector, and that continues to be the domain of public sector investment.

### Policy Support for Private Investment

- Policy support for private investment could be placed in the proper perspective. First, during post-reform regime, the rate of increase in the share of private sector in total investment in agriculture has been less than what it was during pre-reform period. Second, it is recalled that the impact of public investment on private investment is found to be asymmetric. An increase in public investment is found to have positive impact on private investment, but a decline in public investment is found to have increased private investment. Given the commitment of public funds for broader development agenda, the possibility of too much of hiking in public sector investment in agriculture is not quite high. Hence Government has to create a favourable policy and development support environment for private sector (both domestic and foreign agri-business investors) to fill the investment gap in agriculture. For example, there has to be a shift of emphasis from the present situation where the infrastructure investment is dominantly by the public sector towards a system where public-private partnership is function. Third, increased share of private investment in AGFCF trends to improved efficiency of capital use. Fourth, institutional transformation through social capital formation has high potential for increasing the efficiency of capital use (lowering the capital requirement for achieving a targeted output growth). Fifth, farmers (through appropriate development education) have to be convinced that public investment is a better policy instrument than the instrument of subsidization for accelerating productivity and production, and non-price instruments are more important than price instruments for supporting efficient growth in agricultural sector. Sixth, while designing policy options to stimulate private farm investment, the interaction between technology, terms of trade and private investment has to be kept in view. Seventh, public sector investment with proper project portfolio would be crucial for inducing private investment.
- It is recalled from section 9.2.1 that more public investment in technology-infrastructure-institutional development by phasing out subsidies, removal of restraints on exports, reforms in institutional credit system, public investment support for management of canal irrigation, regulatory policy for containing the problems of negative externalities in private ground water exploitation, public investment for preventing land degradation as well as for rehabilitating degraded land, and institutional transformation and social capital are all intended to create a favourable policy and development support environment for private sector.
- It is recalled from the section preceded that public investment with a proper choice of project portfolio would be crucial for inducing private investment. Further, public investment alone cannot be expected to fill the investment gap in agriculture. Hence, the role private investment could be placed in the perspective of huge investment gap.
- Private farm household investment is found to be governed positively by public investment, favourable terms of trade, flow of technology, flow of institutional credit, and subsidies. These determinants of investment behaviour of farm household sector would be suggestive of some implications for policy reforms. First, the private investment is induced positively by public investment, and the public invest, which will have more impact on private investment may have to find a place in the public sector investment portfolio like irrigation and power. Second, the positive impact of terms of trade on private investment would challenge the policy of total subsidy withdrawal, suggesting the need for a gradual phasing out in a properly sequenced manner. Further, the positive impact of subsidy on private investment would also warrant the gradual and selective withdrawal of subsidies. For example, subsidy on the development of private irrigation infrastructure agricultural implements/machinery, land development, dairy/animal husbandry may be needed for targeted group. Third, private investment is found

to be influenced positively by flow of institutional credit (Details in section 9.1.2). But, a review of rate of interest, credit limit, and repayment schedule would make this support system effective in impacting private investment. Further, the credibility of public research and extension system, and its resilience to meet the emerging technological needs of a competitive agriculture regime should be sharpened to support the farmers.

- In areas like agro-processing and value addition, and production of host of horticultural products such as vegetables, flowers, medicinal plants, and aromatic plants, the tie-up between corporate sector and farmers (better farmer groups) is crucial to meet the emerging domestic and international demand. But public investment (may be in partnership mode with regulatory framework) on infrastructure and institutions alone would promote this kind of development alliance between corporate sector and farmers. Mere announcement of tax holiday may not be strong enough to motivate corporate sector to branch into this kind of tie-up. There are other areas like seed, bio-fertilizer, bio-pesticides, agricultural implements/ machinery, drugs, sugar, food processing and electricity which are probable candidates for corporate investment. These areas of investment have backward and forward linkages with agriculture. As already discussed, one of the top priority areas of corporate investment is investment in infrastructure (especially in case of both quasi-public and private goods) with proper regulatory mechanism.
- In agri-biotechnology revolution, corporate sector has reached the commercialization stage. Integration of agri-biotechnology with down stream agri-business companies has given rise to successful technology-based firms with high potential size of the international markets. Public policy support and infrastructural support are required to attract Venture Capital of Corporate sector into this area.

Table-3.1: Distinct Growth Epochs in Aggregate and Agriculture GFCF in India at 1993/94 prices

Period	Annual compound growth rates (%) (CSO series based)		
	Aggregate	Agriculture & allied sectors	Agriculture
<b>A. Broad periods</b>			
1960/61 to 1980/81	4.35	6.2	6.34
1980/81 to 1999/2000	5.85	1.83	1.38
<b>B. Decade</b>			
1960s	4.43	6.39	6.48
1970s	5.14	6.08	6.06
1980s	4.86	-0.40	-0.96
1990s	5.99	2.64	2.05

Table-3.2A: Decadal Averages of Capital Formation as Percentage to GDP at 1993/94 Prices

Decade	CSO series based		
	Aggregate GFCF	Agriculture & allied sectors GFCF	Agriculture GFCF
1960s	17.4	2.5	2.3
1970s	18.6	2.7	2.5
1980s	21.2	2.5	2.3
1990s	22.1	1.7	1.5

Table-3.2.B: Decadal Averages of Ag.GDP as a Percentage of Aggregate GDP at 1993/94 Prices

Decade	% share of Ag. GDP in Aggregate GDP	
	Agriculture & allied sectors	Agriculture
1960s	47.8	42.0
1970s	42.8	37.7
1980s	36.4	33.1
1990s	29.1	26.4

Table-3.3: Decadal Averages of Share of Agriculture in Aggregate Capital Formation at 1993/94 Prices

Decade	Percent to aggregate GFCF	
	Agriculture & allied sectors	Agriculture
1960s	14.4	13.5
1970s	14.4	13.6
1980s	11.6	10.7
1990s	7.8	6.9

Table-3.4: Decadal Averages of Ag.GFCF as Percentage of Agriculture GDP at 1993/94 Prices

Decade	GFCF	
	Agriculture & allied sectors	Agriculture
1960s	5.8	6.1
1970s	6.9	7.4
1980s	7.4	7.5
1990s	6.5	6.2

Table-3.5: Trends in Compound Growth Rates (%) of GCF in Agriculture as Between Public and Private Sector at 1993/94 Prices

Decade	Growth Rates (%)			
	Agriculture & allied		Agriculture	
	Public sector	Private sector	Public sector	Private sector
1960s	2.62	9.55	2.54	9.81
1970s	9.50	7.81	9.60	7.90
1980s	-3.89	2.62	-4.38	2.08
1990s	-0.11	3.73	-0.16	3.04

Source: Thulasamma (2003)

Table-3.6: Trends in Public and Private Sector Growth Rates of GFCF in Agriculture

Period	Growth rates (%)		
	Public	Private	Total
1982-92	-2.5	5.2	1.6
1992-99	0.8	3.5	2.3
1992-97	1.5	4.2	2.8
1997-99	-1.1	1.8	1.1

Source: Adopted from Rip Landes and Gulati (2004)

Table-3.7: Trends in Public Sector GCF in Agriculture at 1993/94 Prices (Rs. Billion)

Year	C-I	C-II	C-III	% change since 1974/75		
				C-I	C-II	C-III
1974-75	34.49	39.49	75.23	-	-	-
1984-85	69.21	81.25	125.85	100.0	105.7	67.30
1994-95	53.97	78.78	89.27	-22.1	-3.3	-29.1
1998-99	48.18	67.72	69.65	-10.8	-14.0	-22.0

Source: Computed drawing data from Gulati and Bhatla (2002)

Table-3.8: Percentage Share of Public and Private Sector in GCF in Agriculture and Allied Sectors at 1993/94 Prices (CSO Series Based)

Years	Share (%) in GCF in agriculture and allied sectors	
	Public sector	Private sector
1960-61	45.6	54.4
1970-71	37.5	62.5
1980-81	51.3	48.7
1985-86	44.0	56.0
1990-91	28.9	71.1
2002-03	24.3	75.7

Sources: Adopted from Thulasamma (2003). CSO, New Delhi.

Table-3.9: Percentage Share of Public Sector in GCF in Agriculture under Three Concepts of Public Sector Investment at 1993/94 Prices

Year	% share of public investment		
	Concept-I	Concept-II	Concept-III
1980-81	51.30	54.64	64.49
1985-86	43.96	48.29	56.15
1990-91	30.41	38.33	41.46
1995-96	30.23	36.53	39.66
1998-99	25.34	32.30	32.92

Source: Adopted from Gulati and Bathla (2002)

Table-3.10: Distribution of Public Investment in Agriculture by Enterprise Category at 1993/94 Prices

TE	% share			
	Agriculture & allied	Forestry	Fishery	Total
1983	94.22	5.73	0.05	100.00
1993	88.75	11.19	0.06	100.00
1998	90.50	9.48	0.02	100.00

Source: Adopted from Gulati and Bathla (2002)

Table-3.11: Distribution of Public Expenditure on Agriculture and Allied Sectors by Government Departments\* (in percentage)

TE	Total share (%) of agriculture & allied sectors	% share of	
		DCU	NDCU
1983	94.22	91.43	2.79
1993	88.75	87.55	1.20
1998	90.51	79.14	11.37

\*Departmental Commercial Undertaking (DCU) and Non-departmental Commercial Undertaking (NDCU)

Source: Adopted from Gulati and Bathla (2002)

Table-3.12: Compositional Distribution of Public Investment in Agriculture at 1980-81 Prices, as per Broad Investment Series

Investment item	Plan period annual expenditure (Rs.crore)			
	V plan	VI Plan	VII Plan	VIII Plan
Crop husbandry	688	251	91	24
Food & storage	1266	1040	675	720
Irrigation	1493	1458	1247	1081
Fertilizer industry	266	130	71	19
Cooperation	216	187	101	60
Roads	168	251	233	200
Total-I	4097	3313	2418	2104
Total-II: Other 16 investment items	299	319	338	462
Grand Total	4396	3632	2755	2566

Source: Developed from Data reported in Chand (2000)

Table-3.13: Percentage Distribution of Fixed Capital Expenditure of Households in Agriculture: All India Estimates.

Capital asset	% share		
	1971/72	1981/82	1991/92
Machinery and equipment	43.20	51.95	47.80
Wells and other irrigation structures	26.80	20.45	24.70
Land improvement	16.50	15.25	12.91
Farm houses and animal sheds	10.50	4.55	3.67
Orchards and plantations	1.80	2.80	5.08
Other capital assets	1.20	5.00	6.26

Source: Gulati and Bathla (2002)

Table-3.14: Changes in Total GCF and AGCF during Pre-Reform and Post-Reform Decade

(At 1993-94 prices)

Decade/year	Total GCF (Rs.Crore)	% change	AGCF (Rs.crore)	% change
Pre-Reform Decade				
1981-82	125859	-	14079	-
1982-83	114461	-9.0	14529	+3.2
1983-84	105581	-8.0	14725	+1.35
1984-85	128063	+21.0	14948	+1.51
1985-86	144777	+13.0	14132	-5.46
1986-87	143533	-1.0	13708	-3.00
1987-88	122274	-15.0	14294	+4.27
1988-89	158291	+29.0	14762	+3.27
1989-90	159512	+0.77	13424	-9.06
1990-91	166077	+4.11	16416	+22.29
Post-Reform Decade				

1991-92	172863	-	14965	-
1992-93	178248	+3.11	16141	+7.86
1993-94	181133	+1.62	15249	-5.53
1994-95	229879	+26.91	16785	+10.07
1995-96	284557	+23.78	17689	+5.38
1996-97	252555	-11.25	18326	+3.60
1997-98	261541	+3.56	18305	-0.11
1998-99	240672	-7.98	18964	+3.60
1999-00	268527	+11.57	21388	+12.78
2000-01	274917	+2.38	19451	-9.06

Data source: National Accounts Statistics-EPW Research Foundation, July 2002

Table-3.15: Trends in Percentage Share of Public and Private Sector in Total AGCF during Pre-Reform and Post-Reform Decade

(At 1993-94 prices)

Decade/year	% Share in Total AGCF	
	Public sector	Private sector
Pre-Reform Decade		
1981-82	50.6	49.4
1982-83	48.8	51.2
1983-84	48.9	51.1
1984-85	46.3	53.7
1985-86	44.0	56.0
1986-87	42.8	57.2
1987-88	42.3	57.7
1988-89	38.6	61.4
1989-90	37.0	63.0
1990-91	29.6	70.4
Post-Reform Decade		
1991-92	28.9	71.1
1992-93	28.1	71.9
1993-94	33.0	67.0
1994-95	33.0	67.0
1995-96	30.9	69.1
1996-97	28.9	71.1
1997-98	25.0	75.0
1998-99	26.0	74.0
1999-00	24.4	75.6
2000-01	23.2	76.8

Source: 1. National Accounts Statistics-EPW Research Foundation, 2002  
2. Economic Survey: 2003-04, Government of India.

Table-6.1: State-wise Analysis of Capital Expenditure and Trend Growth Rates of Capital Expenditure during 1974-75 to 1996-97

(At 1988-81 prices)

States	Average per hectare expenditure/annum (Rs.)		Trend Rate of Growth (%)	
Andhra Pradesh	160		-0.78	
Assam	172		-0.98	
Bihar	182		-4.78	
Gujarat	186		-1.16	
Haryana	198		-2.05	
Himachal Pradesh	323		-2.99	
Jammu & Kashmir	1242		-1.17	
Karnataka	146		-1.66	
Kerala	295		-1.56	
Madhya Pradesh	99		-2.57	
Maharashtra	323		-1.87	
Orissa	185		-2.57	
Punjab	616		-5.39	
Rajasthan	76		-1.22	
Tamil Nadu	97		-3.25	
Uttar Pradesh	299		-2.80	
West Bengal	119		-3.39	
Goa, Daman and Diu	1554		-0.90	
Arunachala Pradesh	1148		4.57	
Manipur	1295		-0.61	
Meghalaya	500		2.94	
Mizoram	1606		0.21	
Nagaland	702		-6.90	
Sikkim	537		0.42	
Tripura	1043		0.31	
Union Government	29		-11.16	
All India	239		-3.16	

Source: Adopted from Chand (2001)

Table-6.2: Public – Private Investment Intensity and Investment Growth in Agriculture: State-wise Analysis – 1987/1999

(At 1980-81 prices)

States	Investment Intensity (Rs./ha)		Investment Growth Rate (%)	
	Public sector	Private sector	Public sector	Private sector
Andhra Pradesh	2.40	2.16	0.48	6.10
Assam	2.16	59	-6.18	1.66
Bihar	200	86	-11.00	2.65
Gujarat	244	-	1.56	5.56
Haryana	238	407	3.01	8.97
Himachal Pradesh	408	531	0.00	6.87
Jammu & Kashmir	1369	146	0.88	7.43
Karnataka	165	409	5.28	6.18
Kerala	340	591	2.36	5.85
Madhya Pradesh	119	313	-4.95	10.82
Maharashtra	367	311	1.39	8.93
Orissa	207	49	-1.68	2.77
Punjab	543	397	10.89	9.45
Rajasthan	109	272	2.91	10.06
Tamil Nadu	174	564	0.64	7.22
Uttar Pradesh	325	337	0.11	5.18
West Bengal	206	147	0.76	7.06
North-Eastern States	1132	229	-1.08	6.91
Union Territories	1007	1034	-2.36	2.9
Union Government	21	-	-0.95	-
All India	265	288	0.43	7.44

Source: Adopted from B.C.Roy and Suresh Pal (2002)

Table-6.3: Public-Private Sector Investment and AGDP during 1987-99: State-wise Analysis

(At 1980-81 prices)

States	Investment as percent of AGDP	
	Public investment	Private investment
Andhra Pradesh	5.06	5.85
Assam	3.84	2.34
Bihar	3.30	2.31
Gujarat	7.46	9.12
Haryana	2.73	7.00
Himachal Pradesh	4.99	7.70
Jammu & Kashmir	19.08	4.36
Karnataka	4.70	12.67
Kerala	3.60	7.41
Madhya Pradesh	4.23	10.28
Maharashtra	9.78	9.87
Orissa	6.20	1.97
Punjab	4.97	8.97
Rajasthan	4.16	10.04
Tamil Nadu	3.10	10.57
Uttar Pradesh	5.26	6.72
West Bengal	2.08	2.04
North-Eastern States	18.44	4.20
Union Territories	10.87	11.70
All India	5.13	6.75

Source: Adopted from B.C.Roy and Suresh Pal (2002)

Table-7.1: Estimates of ICOR and MEI in Indian Agriculture during 1952/53 to 1991/92

Period	ICOR	MEI
1952/53 to 1964/65	3.47	0.29
1967/68 to 1977/78	4.17	0.24
1978/79 to 1986/87	4.37	0.23
1987/88 to 1991/92	3.32	0.30

Source: Misra, V.N. and Peter B.R. Hazal (1996)

Table-7.2: Estimates of ICOR and MEI in Indian Agriculture: 1974/75 to 1994/95 at 1981/82 prices

Period	ICOR		MEI	
	CSO Series	Broad series	CSO Series	Broad series
I. 1974/75 to 1978/79	3.77	6.52	0.27	0.15
II. 1980/81 to 1984/85	2.95	4.05	0.34	0.25
III. 1985/86 to 1989/90	2.22	2.82	0.45	0.35
IV. 1990/91 to 1994/95	2.75	3.44	0.36	0.29

Source: Adopted from Chand (2000), Estimates based on total investment of both public and private sectors.

Table-7.3: Plan period estimates of ICOR and MEI in Indian Agriculture at 1993/94 prices

Plan	Plan years	ICOR	MEI
Fourth plan	1969/74	4.81	0.207
Fifth plan	1974/78	3.09	0.323
Sixth plan	1980/85	1.64	0.606
Seventh plan	1985/90	2.14	0.465
Annual plan	1990/91	3.35	0.298
Eighth plan	1992/97	1.95	0.511

Source: Gulati and Bathla (2002)

Table-7.4: Estimates of ICOR in Agriculture: A State-wise Analysis – 1992/1997

(At 1980-81 prices)

ICOR Range	Cluster of States
< 2.0	West Bengal (1.81)
2.0 – 3.0	Andhra Pradesh (2.97), Gujarat (2.56), Orissa (2.01), Rajasthan (2.56), and Tamil Nadu (2.16)
3.0 – 4.0	Bihar (3.10), Haryana (3.71), Kerala (3.51), Maharashtra (3.34) and Punjab (3.38).
4.0 – 5.0	Assam (4.50), Karnataka (4.44) and Madhya Pradesh (4.41).
5.0 – 8.0	Himachal Pradesh (5.55), Uttar Pradesh (5.58) and Union Territories (7.57)
> 8.0	Jammu & Kashmir (8.77) and North-Eastern states (8.28)
All India	3.66

Source: adopted from B.C.Roy, 2001

Figures in parentheses are the respective State ICORs.