Chapter - 2

CONCEPTUAL FRAMEWORK AND METHODOLOGY
2.1: Conceptual Background

The productivity growth in agriculture is both a necessary and sufficient condition for the development of the sector as well as the economy. It is a necessary condition in the sense that it enables agriculture to avoid getting trapped in Ricardo’s law of diminishing returns to which the sector is more prone. On the other hand it is a sufficient condition because it increases production at reduced unit cost/prices in real terms (Sakia, 2009). The term “productivity”, however, is often misused in the literature; it is used as synonymous to “labour productivity” in case of manufacturing sector, while used as synonymous to “yield productivity” in the case of agriculture. But, the consideration of yield alone as a measure of productivity provides misleading indication of the degree of productivity improvement in agriculture (Coelli, 1996).

Productivity growth in agriculture has remained a serious concern for intense research over the last five decades. Solow (1957) was the first to propose a growth accounting framework, which attributes the growth in TFP to that part of growth in output, which cannot be explained by growth in factor inputs like land, labour and capital. Development economists and agricultural economists have computed productivity and have examined productivity growth over time and differences among countries and regions. Productivity growth is essential to meet the food demands arising out of steady population and economic growth. TFP is an important measure to evaluate the performance of any production system and sustainability of the growth process (Kumar et al., 2008).

2.1.1: Technical Progress

Technical progress has two components: technical change and improvement in technical progress. The former represents improvements in best production practices, while the latter occurs when actual production practices move closer to the existing best practice. Substantial scope exists for raising TFP by enhancing the technical efficiency. Yanrui (1995) had demonstrated that technical efficiency in the state industry, rural industry and agriculture in post-reform China was 50 to 60 per cent between 1985 and 1991. As pointed out by Lewis (1978) productivity is the ‘engine of growth’ in the long-run. Technological advancement has been a major contributing factor to economic growth. Since publication of the pioneering works of Schultz (1953), Solow (1957), and Griliches (1964), voluminous literature dealing with the
measurement and analysis of productivity at different levels of aggregation has appeared.

Methods of production change over time and it is important to be able capture the effects of such changes on output. Capturing such effects can ideally be done within the production function framework. Starting with a simple production relationship in which output depends on capital input $K$, and labour $L$, the production function can be expressed as:

$$Q = f(K, L)$$ (1)

Where $Q$ (the output) depends on how much of $K$ and $L$ is used. If the levels of $K$ and $L$ are increased / reduced, then it is expected that $Q$ will also correspondingly increase/decrease. However, $Q$ can also increase by using the same level of $K$ and $L$. This is possible if a superior technology is used in the production process. Output growth however can also be attributed to factors other than growth with the conventionally defined inputs. When this is the case, then technical progress takes place. In terms of the production relations, such a change represents a shift in the production frontier and can be defined as:

$$Q = A(t) f(K, L)$$ (2)

Where $A(t)$ represents all the influences that go into determining $Q$ besides $K$ and $L$. Changes in $A$ overtime represent technical progress. It is important to note that technical change may influence output in two distinct ways. First, technical change may influence output by affecting not a single input but all the inputs. This would be a case of neutral technical progress or disembodied technical progress. Equation (1) above is a case of neutral technical progress. The second case is where technical change affects output by augmenting either capital (capital-augmenting technical progress) or labour (labour-augmenting technical progress). These two cases are commonly referred to as disembodied technical progress and can be represented as:

$$Q = f[A(t) K, L]$$ (3)

and

$$Q = f[K, A(t) L]$$ (4)
Equation (3) represents the capital-augmenting technical progress while equation (4) is a case of labour-augmenting technical progress. In all the three cases represented by equations (2)-(4), the empirical question is how to measure $A(t)$.

2.1.2: Productivity Growth

The concept of technical progress is closely related to productivity growth. In fact, productivity growth has been shown to be a major source of growth of aggregate output (Solow, 1957) and of agricultural output (Hayami and Ruttan, 1985). The latter have shown that agricultural output can grow in two main ways: an increase in use of resources of land, labour, capital and intermediate inputs or through advances in techniques of production through which greater output is achieved through a constant or declining resource base. The latter, also referred to as productivity, occurs without a corresponding change in output, occasioning a rise in the ratio of total outputs to inputs. Seen in this way, productivity can be defined simply as a measure of the increase in output that is not accounted for by the growth of production inputs. Under certain assumptions of efficiency, productivity growth and technical change are synonymous (Grosskopf, 1993).

Conventionally, productivity is measured by an index of output divided by inputs. Two measures of productivity are frequently used: the partial factor productivity (PFP) and total factor productivity (TFP). Partial productivity measures the contribution of one factor (say labour or capital) to output growth keeping the other factors constant. As such we have the concepts of labour productivity, capital productivity, which estimate the efficiency of resource use. PFP is simply the ratio of output and any one of the inputs, typically labour or land. In notation form this can be expressed as:

$$\text{PFP} = \frac{Y}{X_i} \quad (5)$$

Where $Y$ is output and $X_i$ is input $i$, although commonly used, the partial productivity measure does not truly reflect whether productivity growth is because of more use of inputs or improvement in the efficiency of their use or technology improvement. Further, it also ignores time, secondary products, inputs other than land, labour and capital and externalities, all of which should be included in a sustainability measure (Barnell et al., 1995). Therefore the interest shifts to the Total Factor Productivity (TFP). Any growth in output that is not explained by some index of input growth is
attributed to changes in technology or more broadly Total Factor Productivity. TFP measures the net growth of output per unit of total inputs. As such, its level is determined by how efficiently and intensely the inputs are utilized in production. Thus, TFP growth is a catch-all measure that captures changes in efficiency in addition to pure technical change in the terms of shifts in the production function. TFP is regarded as a more accurate productivity measure than partial productivity measure.

2.1.3: Technical Efficiency

The concept of technical efficiency entails a comparison between observed and optimal values of output and inputs of a production unit (Sadoulet and Janvry, 1995). This comparison takes the form of the ratio of observed to maximum potential output obtainable from the given input, or the ratio of the minimum potential to observed input required to produce the given output, or some combination of the two. These two give rise to the concepts of technical and allocative efficiency. A productive entity is technically inefficient when, given its use of inputs, it is not producing the maximum output possible (output distance), or given its output, it is using more inputs than is necessary. Similarly, a production unit is allocatively inefficient when it is not using the combination of inputs that would minimise the cost of producing a given level of output (Sadoulet and Janvry, 1995).

Efficiency and productivity are closely related. Changes in productivity are due to differences in production technology, differences in the efficiency of the production process, and differences in the environment in which production takes place (Grosskopf, 1993). Productive efficiency is therefore an important determinant of productivity and should be incorporated in productivity analyses.

2.1.4: Total Factor Productivity

Index of Total Factor Productivity measures the growth of net output per unit of total factor input. In the context of the methodology of growth accounting, which has been extensively used and refined by Denison (1967, 1985), total factor productivity growth is also termed as the residual factor because it represents that part of the growth of net output that is not accounted for by the growth of basic factor inputs such as land, labour and capital. In the production function framework, total factor productivity growth indicates technical progress.
which represents shifts in the production function over time. Thus, apart from
improvements in techniques of production, advancement in knowledge and greater
efficiency of the production system, betterment in the management practices,
improvement in the quality of inputs, and increase in the degree of utilisation of
resources are also included in the concept of technical progress defined in the
production function framework. Basically, this is the concept of autonomous
disembodied neutral technical progress as defined by Hicks (1967) and Harrod
(1973). It is defined simply as the ability of the economy to obtain greater output
from the given combination of inputs over a period of time (Dholakia 1993).

As already indicated, most analyses of agricultural productivity have utilised
the TFP concept. Because of its superiority over other measures of productivity, TFP
is examined in some detail in this sub-section. Grosskopf (1993) outlines the basic
procedure for deriving the TFP index. Considering two time periods $t$ and $t+1$,
corresponding outputs and inputs denoted by $y^t$ and $y^{t+1}$ and $x^t$ and $x^{t+1}$, the production
transformation model $S_t$ for period $t$ can be expressed as:

$$S^t = \{ (x^t, y^t) : x^t \text{ can produce } y^t \} \tag{6}$$

Similarly for $S^{t+1}$

$$S^{t+1} = \{ (x^{t+1}, y^{t+1}) : x^{t+1} \text{ can produce } y^{t+1} \} \tag{7}$$

The set $S$ describes all the feasible input-output pairs at a given point in time.
In a similar manner, technology can also be described with a production function in
period $t$ as

$$Y^t = \max \{ y^t : (x^t, y^t) \in S^t \} \tag{8}$$

and in period $t+1$

$$y^{t+1} = \max \{ y^{t+1} : (x^{t+1}, y^{t+1}) \in S^{t+1} \} \tag{9}$$

Assuming neutral disembodied technology in the Hicksian sense (that is
technology independent of input) the production functions in the two periods can be
denoted by:

$$Y^t = A(t) f(x^t)$$

$$Y^{t+1} = A(t+1) f(x^{t+1}) \tag{10}$$
where $A$ is a technology shift parameter.

Based on equation (10), total factor productivity (TFP) can be defined for the two periods as:

$$\text{TFP} (t) = \frac{y^t}{f(x^t)} = A (t)$$
$$\text{TFP} (t+1) = \frac{y^{t+1}}{f(x^{t+1})} = A (t+1)$$

(11)

The total factor productivity growth can then be defined as the change in total factor productivity between period $t$ and $t+1$, that is:

$$\frac{\text{TFP} (t+1)}{\text{TFP} (t)} = \frac{A (t+1)}{A (t)}$$

(12)

It needs to be noted here that technical change and productivity growth are synonymous in the special case when production is technically efficient (Grosskopf, 1993).

2.1.5: Measuring Total Factor Productivity

Three approaches for the measurement of Total Factor Productivity are the most representative: (i) The parametric approach, (ii) The accounting approach and the (iii) Non-parametric approach.

1: The Parametric approaches

The concept of efficiency as earlier defined relates to how inputs are effectively used to produce a given output. Maximum efficiency is achieved when the most efficient production function is used and when the marginal value products of each factor on the production function is equal to its price. Efficiency, whether technical, allocative, or economic can be measured using a number of approaches which essentially involve the measurement of the frontier production function (Sadoulet and Janvry, 1995). These are:

(i) Engineering approaches

This approach involves assembling data from experimental fields and estimating the best production available and the production function currently in use. The production function to be estimated could take the form:

$$Q = f (x, Z_f, Z_p)$$

(13)

Where $x$ represents factors used in production (land, fertilizer, seeds, insecticides, etc.), $Z_f$ are the variables that characterize the particular farm’s environment and $Z_p$.
are dummies which earmark the use of best practices (use of quality seeds, soil conservation, weed control, etc.). Two sets of estimates are then obtained from equation (13) above. The first is the yield estimate specific to the firm \( f_1 \) (when \( Z_p \) is set to actual practice) and \( f_2 \) (where \( Z_p \) is set to actual practice values). The farmer-specific efficiency measure is then the difference between the two measures. The farmer-specific efficiency measure can then be regressed econometrically against a set of exogenous variables that characterize the farmer’s circumstances. This approach has been used in a number of studies, the best example being that by Herdt and Mandac, 1981 in Philippines. In Kenya, the approach is mainly used in agricultural research stations and increasingly on on-farm research. Its results usually form the basis of input use recommendations by agricultural research institutions.

This approach has a number of advantages that make it appealing in the assessment of efficiency in agriculture (Sadoulet and Janvry, 1995): (i) The approach is simple and straightforward. Its results are also very easy to interpret. (ii) The data required for this analysis is directly generated from the experiments, and are likely to be more accurate than data collected by other means. (iii) The approach generates a good indicator of efficiency that incorporates and reflects on technical changes associated with different methods of production, technologies, etc.

(ii) Use of average production functions

This is a particularly useful method of measuring differences in technical and allocative efficiencies between different categories of farms (e.g. small and large), different regions, and over time. The approach involves the estimation of a production function with farm, regional or time dummies included in the function. The dummies in the functions are meant to capture allocative and technical efficiency differentials. Yotopoulos and Lau (1973) provide a good example of this approach for estimating efficiency. In their analysis, the two authors specify and estimate a Cobb-Douglas production and profit functions of the form:

\[
Q = ax^a z^b (14)
\]

and

\[
\pi = a^* z^{\beta^*} p^{1-\alpha^*} W^{\alpha^*} (15)
\]

Where \( x \) is labour used in production with corresponding wage \( w \), \( z \) is a fixed factor, \( q \) is output with corresponding price \( q \), and \( \pi \) is profit. The other variables, namely \( a \)
and $\beta$ and $\alpha$ are parameters. Based on these, Yotopoulos and Lau (1973) formulated and estimated the model below using time series data:

\[
\ln y = \ln a^* + \delta_1 D_1 + \delta_2 D_2 + \delta_3 D_3 + \alpha \ln w + (1-\alpha) \ln p + \beta^* \ln z - w_x/\pi
\]

\[
= \lambda_1 D_1 + \lambda_2 D_2
\]

(16)

where $D_1$, $D_2$, and $D_3$ are dummies for large farms, small farms, and time.

The relevant estimation procedure here is the Zellner seemingly unrelated regression method. This approach requires data on the inputs used, prices, and profits disaggregated by type of farm or region. The obvious advantage of this approach is that it accounts for differences in efficiency between different categories of producers or regions. As already indicated, there are marked differences in terms of resource use and style of production between large and small scale. There are at the same time significant regional differences in agricultural potentiality and efficiency. The main weakness of the approach has to do with the use of the production functions in estimation of efficiency. The first issue is which between the Cobb-Douglas and the CES (or indeed any other form) is the most appropriate functional form of the production function. The second issue has to do with the assumptions made in each case. The Cobb-Douglas production function restricts the elasticity of substitution to unity while the CES production function imposes constancy of elasticity of substitution. These are not particularly realistic assumptions in the context of agricultural production.

(iii) Stochastic frontier analysis

The use of econometric techniques in estimation of efficiency has increased considerably in recent times. This has mainly taken the form of estimating a frontier production function. Econometric approaches developed by Aigner et al., (1977) are among the first to use non-stochastic frontier methods of estimation. Since then, there have been several attempts to use the technique. These attempts vary according to the type of data used (cross-section or panel), the type of variables (quantities only, or quantities and prices) and the number of equations in the model.

(a) Cross-sectional designs

These are by far the most widely used techniques in the estimation of productive efficiency. The process involves the specification and estimation of a production function of the form:
\[ Y_i = f(x_i, \beta) \exp \{v_i + u_i\} \] (17)

where \( \beta \) is a vector of technology parameter, \( x \) are the inputs used and \( i=1,...,I \) indexes producers. The model specifies two random disturbance terms \( v_i \) and \( u_i \). The random disturbance term \( v_i \) is intended to capture the effects of the stochastic noise. It is assumed to be independently distributed with a mean equal to zero and standard deviation equal to \( \sigma_v \). The disturbance term \( u_i \) captures technical inefficiency and is assumed to be independent of \( v_i \). Lovell (1993) shows that the technical efficiency (TE) can be expressed as a reciprocal of the Dubreau-Farrel output oriented technical efficiency. This can be written as:

\[ TE_i = \frac{y_i}{f(x_i, \beta) \exp\{v_i\}} = \exp \{u_i\} \] (18)

Estimation of technical efficiency was first accomplished by Aigner et al. (1977), Battese and Corra (1977). These studies provide estimates of the average technical efficiency over all the observations. The data used was cross-sectional in nature. To estimate the equations, a number of assumptions are necessary. First, it can be assumed that \( v_i = 0 \) and then estimate a deterministic production frontier. The maximum likelihood method (MLE) can then be used as an estimation procedure in this case. The second assumption will be to assume that \( v_i \neq 0 \) and estimate a stochastic production frontier. MLE can also be used in this particular case.

It should be noted that the models above are single-equation models and would require the use of single equation techniques. However, it is also possible to specify and estimate multiple equation models. This is usually more appropriate in order to go around the weaknesses of single equations. By assuming profit maximization behaviour, this approach can be used to yield consistent and efficient estimates of economic efficiency. The approach essentially involves the estimation of a production frontier and the first order conditions for profit maximization. Starting from a typical production relationship of the form (Sadoulet and Janvry, 1995):

\[ q^* = f(x) \] (19)

where \( q^* \) is the maximum output a firm/producer could reach by using the inputs in a technically efficient manner. If the producer is not technically efficient, the predicted level of output with the observed level of inputs will be:

\[ q = f(x) e^u, \ u \leq 0 \] (20)
where $e^u$ is the producer-specific technical efficiency parameter. If the firm is
maximally efficient, $u=0$. If the producer is technically inefficient, $u<0$ and $q<q^*$. In
the collection of data, measurement errors are in most cases unavoidable and the
observed level of $q$ will therefore depend both on the technical error term $u$, and $v$
which captures noise.

$$q = f(x)e^{u+v}, \ E(v) = 0$$  \hspace{1cm} (21)

If we then assume that producers are profit maximizers, then both the output and input
levels are endogenous. This has the implication that both of these functions must be
estimated simultaneously. According to Sadoulet and Janvry (1995), the system of
equation to be estimated is:

$$\ln q = \alpha + \sum_{i=1}^{m} \beta_i \ln x_i + \frac{1}{2} \sum_{i=1}^{m} \sum_{j=1}^{m} y_{ij} \ln x_j + u + v$$

$$C_i = \beta_i + \sum_{j=1}^{m} y_{ij} \ln x_j + w_j, i=1, \ldots, m$$  \hspace{1cm} (22)

where $C_i$ is the share of the factor $i$ in total revenue, calculated as $p_i x_i / pq$. This model
can be estimated using the maximum likelihood approach.

Cross-sectional analyses of efficiency by their very nature provide a snapshot
of the situation at only one particular point in time. The use of such a technique is
associated with a number of advantages: (i) It is possible to include many variables in
the analysis as the data is obtained from a large number of subjects (in this case farmer). (ii) The technique also allows for collection of data on attitudes and
behaviours that may have a bearing on efficiency. (iii) The technique also allows for
the analysis of dispersed subjects, in this case farmers, in different regions or of
different sizes.

Cross-sectional techniques of efficiency analysis however have a number of
disadvantages: (i) Cross-sectional data are typically more difficult to collect and are
associated with increased chances of error. (ii) The techniques are typically more
expensive as they cover more subjects and areas. (iii) Cross-sectional techniques
cannot measure changes, particularly technological changes, which are key
determinants of efficiency. (iv) The approach is static and time bound.

(b) Panel data designs

Panel designs collect repeated measurements from the same people or subjects
over time. Panel data can also be used in estimation of frontier production functions.
Using this kind of data, Schmidt and Sickles (1984) specified and estimated a production frontier model in the form:

\[ Y_{it} = f(x_{it}, \beta) \exp \{v_{it} + u_i\} \]  \hspace{1cm} (23)

where \( t = 1, \ldots, T \) represents the different time periods, \( v_{it} \) is the noise time which varies over producers and time, and \( u_i \) is technical inefficiency. Technical efficiency will vary only over producers and not over time. The variation is as a result of the fact that each producer is observed more than once. Both the GLS and the maximum likelihood method can be used to estimate equation (23) above under certain specific assumptions. The GLS method assumes that \( u_i \) are uncorrelated while MLE will require distributional and independence assumptions. Examples of studies that have used panel data to analyse efficiency in agriculture include Dawson and Lingard (1991), Battese and Coelli (1998).

The most important advantage of using panel data is that it may lead to better efficiency estimates as each producer is observed more than once over a period of time. The other advantage of using panel data models is that they are more capable of capturing the complexity of human behaviour as compared to cross-sectional or time series data models. They can reveal individual level changes and can show how relationships emerge. The approach is however associated with a number of disadvantages mainly in the collection of data. First, it is usually difficult to obtain initial samples of the subject. Second, once the samples have been found, it is difficult and costly to keep the same subjects over time. Thirdly, repeated measures being taken over the same subject may influence the subject’s behaviour and therefore not yield reliable results.

2: Growth Accounting Approach (GAA)

Solow (1957) was the first to propose a growth accounting framework and then Denison (1967 and 1985) refined the approach. In this approach, TFP is measured as a residual factor, which attributes to that part of growth in the output that is not accounted for by the growth in the basic factor inputs. This approach approximates the technological change by the computation of factor productivity indices, mainly the rate of change of total factor productivity indices (Christensen, 1975). The TFP index is measured as the ratio of the index of net output and the index of total factor inputs. The index of total factor inputs is derived as weighted average
of indices of labour inputs, capital inputs and land inputs with relative income shares of the three factors as respective weights. The key feature of the GAA is separation of change in production on account of changes in the quantities of factors of production from residual influences, which include technological progress, learning by doing, etc. Basically there are three main indices used in the GAA: (i) Kendrick Index (KI), (ii) Solow Index (SI), and (iii) Translog Index (TLI).

The Solow residual is defined as 
\[ g_y - \alpha \times g_k - (1 - \alpha) \times g_l \],
where \( g_y \) is the growth rate of output, \( g_k \) is the growth rate of capital, \( g_l \) is the growth rate of labour and \( \alpha \) and \( 1 - \alpha \) stand for share of capital and labour respectively. The Solow residual accurately measures TFP growth if (i) the production function is neoclassical, (ii) there is perfect competition in factor markets, and (iii) the growth rates of the inputs are measured accurately.

The Divisia-Tornqvist index or translog index of TFP is commonly used for computing the total output, total input, and TFP indices can be specified as:

Total Output index: 
\[ \frac{TOI_t}{TOI_{t-1}} = \pi_j \left( \frac{Q_{jt}}{Q_{jt-1}} \right)^{(R_{jt}+R_{jt-1})^{1/2}} \] 
(24)

Total Input index: 
\[ \frac{TII_t}{TII_{t-1}} = \pi_i \left( \frac{X_{it}}{X_{it-1}} \right)^{(S_{it}+S_{it-1})^{1/2}} \] 
(25)

Here, \( R_{jt} \) is the share of \( j \)th output in total output, 
\( Q_{jt} \) is output of the \( j \)th commodity, 
\( S_{it} \) is share of the \( i \)th input in total input cost, and 
\( X_{it} \) is quantity of the \( i \)th input.

For the productivity measurement over a long period of time, chaining indexes for successive time periods is preferable. With chain linking, an index is calculated for two successive periods, \( t \) and \( t-1 \), over the whole period \( 0 \) to \( T \) (sample from time \( t=0 \) to \( t=T \)) and the separate indexes are then multiplied together:

\[ TOI (t) = TOI (1).TOI (2) \ldots \ldots TOI (t-1) \] 
(26)

\[ TII (t) = TII (1).TII (2) \ldots \ldots TII (t-1) \] 
(27)

Finally, the TFP index is computed as

\[ TFP_t = \frac{TOI_t}{TII_t} \] 
(28)

However, Kendrick index and Solow index suffer from some limitations. In contrary, the Translog index is superior to both Kendrick and Solow indices because
Translog index numbers are symmetric in data of different time periods and also satisfy the factor reversal test approximately. It is based on Translog Production Function characterized by constant returns to scale. It allows for variable elasticity of substitution and does not require the assumption of Hicks-neutrality.

3: Non-parametric approach.

The piece-wise linear convex hull approach to estimate frontier was proposed by Farrell (1957) but the application of this methodology increased only after the term Data Envelopment Analysis was coined by Charnes et al. (1978). Data Envelopment Analysis (DEA) is a non-parametric method of frontier estimation that makes use of linear programming. The approach constructs a “piece-wise surface (or frontier) over the data” (Coelli et al., 2005) such that the constructed frontier envelops all given data points, that is, all observed data points lie on or below the production frontier. The benchmark technology is hence constructed from among the observed input-output bundles of various production entities. “Efficiency measures are then calculated relative to this surface” (Coelli et al., 2005).

Compared to the other methods, the approach has four major advantages (Fare et al., 1994 b): First, since it is calculated from distance functions, it only requires data on quantities and thus less data demanding than the Tornqvist-Theil index, this is a distinct advantage, because in general, agricultural input price data are seldom available and such prices could be distorted due to government intervention. Second, it allows for inefficient performance and does not presume an underlying functional form of the production technology. Third, no assumption regarding the optimising behaviour of the producer is necessary. And fourth, since it is a non-parametric index, it does not require econometric estimation. The chosen type of index number then allows decomposition of changes in productivity into technical progress and efficiency changes. However, the disadvantage of DEA is that it does not account for noise (all noise is grouped into inefficiency) and the usual econometric tests of hypotheses and significance cannot be carried out.

DEA uses Distance Functions that allow us to describe a multi-input, multi-output production technology without any specification of a behavioural objective (such as cost-minimization or profit-maximization). The concept of distance function is closely associated with production frontiers. Distance functions can be output-
oriented or input-oriented. An output distance function considers the maximum proportional expansion of the output vector corresponding to a given input vector. It measures the distance of a firm from its production frontier—how close a particular level of output is to the maximum attainable level of output that could be obtained from the same level of inputs if production is technically efficient. Fare et al., (1994) define an output distance function at time $t$ as

$$D^t_0(x^t, y^t) = \inf \{ \theta : (x^t, \frac{y^t}{\theta}) \in S^t \} = (\sup \{ \theta : (x^t, \theta y^t) \in S^t \})^{-1}$$  \hspace{1cm} (29)$$

Distance function is defined as the inverse of the maximum proportional increase in the output vector $y^t$, given the set of inputs $x^t$ and production technology $S^t$. The distance so computed is equivalent to the reciprocal of Farrell’s (1957) measure of technical efficiency. The superscript $t$ associated with $D$ refers to which period’s production frontier is used as reference technology. The calculation of distance functions and how they can be used to give insights about efficiency change and technical change is illustrated diagrammatically in Figure 2.1.

In Figure 1, production possibility sets are depicted for period’s $t$ and $t+1$. Firm B is lying on the frontier in both the time periods, implying it is fully technically efficient. Firm A lies inside the production frontier. For firm A, the distance from the
production point in time period \( t \) to the frontier in time period \( t \), that is, \( D'_0(x_t,y_t) \) is given by \( \frac{OA_t}{OB_t} \). This ratio is less than one implying the firm is inefficient. In case of firm \( B \), the distance from its production point to the frontier shall be equal to one as it lies on the frontier. Firm \( A \)’s distance of its production point from the frontier in time period \( t+1 \), \( D'^{t+1}_0(x_{t+1}, y_{t+1}) \), is given by \( \frac{OA_{t+1}}{OB_{t+1}} \). The comparison of these two distance functions tells about the performance of firm \( A \) on efficiency front. If firm \( A \) has become more efficient in time period \( t+1 \) than it was in time period \( t \), then its production point in \( t+1 \) would be closer to the same period frontier than in the preceding period. In other words, the distance computed from \( D'^{t+1}_0(x_{t+1}, y_{t+1}) \) would be greater than \( D'_0(x_t,y_t) \).

The above distances are calculated from same period’s production frontier. However, the distances can also be computed using some other period’s production frontier / technology. For example, for firm \( A \), distance of its production point in time period \( t \) can be calculated with respect to frontier of time period \( t+1 \). This distance, \( D'^{t+1}_0(x_t,y_t) \) is given by \( \frac{OA_t}{OB_{t+1}} \). Similarly, the distance of firm \( A \)’s production point in time period \( t+1 \) can be computed using time period \( t \)’s frontier as reference technology. This distance, \( D'_0(x_{t+1},y_{t+1}) \), is given by \( \frac{OA_{t+1}}{OB_t} \). A comparison of these mixed-period distance functions can tell us about whether or not technical change has taken place. If what is produced in time period \( t+1 \) could not have been produced in time period \( t \), then the distance \( D'_0(x_{t+1},y_{t+1}) \) would be greater than one. Similarly, if the distance computed of period \( t \)’s production point from period \( t+1 \)’s frontier exceeds that from period \( t \)’s frontier, that is \( D'^{t+1}_0(x_t,y_t) > D'_0(x_t,y_t) \), then it implies an outward shift of production frontier in time period \( t+1 \).

**Malmquist TFP Index**

The index is constructed from distance functions, which make it easier to calculate and isolate changes in efficiency. The Malmquist TFP index was first introduced by Caves et al., (1982). They defined the TFP index using Malmquist input and output distance functions, and thus the resulting index came to be known as the Malmquist TFP index.

To demonstrate the Malmquist Index, Grosskopf (1993) assumes for each period \( t = 1, \ldots, T \), the existence of a production technology \( S^i \) model that transforms inputs \( x^i \) into outputs \( y^i \). It assumes further that \( S^i \) is sufficiently regular to define
meaningful output distance functions. The distance with respect to two different time
periods are:

\[ D_0^t(x^{t+1}, y^{t+1}) + \inf\{\Theta: (x^{t+1}, y^{t+1}) / \Theta \in S^t\} \]  

(30)

And

\[ D_0^{t+1}(x^t, y^t) + \inf\{\Theta: (x^t, y^t) / \Theta \in S^{t+1}\} \]  

(31)

The first distance function in equation (30) measures the maximum proportionate
change in outputs required to make \((x^{t+1}, y^{t+1})\) feasible in relation to the technology at
the previous period \(t\). Similarly, equation (31) measures the maximum proportional
change in output required to make \((x^t, y^t)\) feasible in relation to the technology at \(t+1\).

Based on these, an output based Malmquist productivity can be defined as:

\[ M^*_0 = \frac{D_0^t(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \]  

(32)

\[ M^{t+1}_0 = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \]  

(33)

The Malmquist index can then, according to Fare, Grosskopf, Lindgren
and Roos (1989), be arrived at by taking the geometric mean of the two-output based
indices in equation (32) and (33) as:

\[ M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \left[\frac{D_0^t(x^{t+1}, y^{t+1}) \cdot D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)^2}\right]^{\frac{1}{2}} \]  

(34)

Equation 27 can be also re-written as:

\[ M_0(x^{t+1}, y^{t+1}, x^t, y^t) = D_0^{t+1}(x^{t+1}, y^{t+1}) \left[\frac{D_0^t(x^{t+1}, y^{t+1}) \cdot D_0^t(x^t, y^t)^2}{D_0^{t+1}(x^{t+1}, y^{t+1})^2}\right]^{\frac{1}{2}} \]  

(35)

Based on equation (30), the efficiency change (EC) and the technical change (TC) can
be expressed as:

\[ \text{Efficiency change} = \frac{D_0^{t+1}(x^{t+1}, y^{t+1})}{D_0^t(x^t, y^t)} \]  

(36)

\[ \text{Technical change} = \left[\frac{D_0^t(x^{t+1}, y^{t+1}) \cdot D_0^t(x^t, y^t)^2}{D_0^{t+1}(x^{t+1}, y^{t+1})^2}\right]^{\frac{1}{2}} \]  

(37)

Hence the Malmquist productivity index is simply the product of the change in
relative efficiency that occurred between period’s \(t\) and \(t+1\), and the change in
technology that occurred between period’s \(t\) and \(t+1\). A value of Malmquist TFP
index equal to one implies there has been no change in total factor productivity across
the two time periods, greater than one implies an improvement in TFP and a value
less than one is interpreted as a regress in TFP. A similar interpretation applies to the two components as well.

2.2: Methods used in the study

Based on the availability of data, suitable tools were applied for analysing the data and getting the results to derive logical conclusion. Statistical tools such as, Coefficient of Variation, Annual Growth Rate and Compound Annual Growth Rate (CAGR) have been used.

India Average Annual Growth Rates of Area, Production and Yield of Principal Crops were measured in percentage terms. All India Annual Growth Rate of Fertilizer Consumption, Compound Growth Rates of Production and Productivity of Principle crops in India from 1980-81 to 2009-10 were also measured.

2.2.1: Compound Annual Growth Rate (CAGR)

In order to study the year-wise growth in the variables percentage growth rates and compound annual growth rates (CAGR) have been calculated. It is a simple measure to find out the year-wise increase and decrease in the variables under study. The compound annual growth rate is a number that represents a steady level of growth from the initial value to an ending value as it determines the average of year to year growth rate for time series data. The percentage compound annual growth rate in a variable has been calculated by firstly regressing the natural logarithm of the variable on time which is called the semi-log model is used in the following form:

\[ Y_t = Y_0 (1+r)^t \]

Taking natural log of the above equation, we have

\[ \ln Y_t = \ln Y_0 + t \ln (1+r) \]

Putting \( \ln Y_t = Y^* \), \( \ln Y_0 = a \) and \( \ln (1+r) = bt \) then the above equation can be written as:

\[ Y^* = a + bt \]

Where, \( Y \) is the variable in question

\( t \) is time variable

\( a \) is intercept
r is compound rate of growth

Compound growth rate \( r \) can be computed by estimating the above equation as:

\[
r = \{\text{antilog} (b) - 1\} \times 100
\]

2.2.2: Coefficient of Variation

For calculating Coefficient of Variation the following formula was used

\[
CV = \frac{\sigma}{\mu} \times 100
\]

Where, \( \sigma \) is the Standard Deviation

\( \mu \) is the mean of the variable

2.2.3: The Malmquist Total Factor Productivity (TFP) index

TFP is an index that relates changes in all outputs to changes in all inputs. As proposed by Lynam and Herdt (1989), a non-negative trend in TFP over the period of interest implies sustainability. The present study is based on Non-parametric approach and uses Malmquist productivity index for measuring the TFP of Indian agriculture in order to establish the sustainability of agriculture. The index is constructed from distance functions, which make it easier to calculate and isolate changes in efficiency. The Malmquist TFP index was first introduced by Caves, Christensen and Diewert (1982). They defined the TFP index using Malmquist input and output distance functions, and thus the resulting index came to be known as the Malmquist TFP index.

To demonstrate the Malmquist Index, Grosskopf (1993) assumes for each period \( t = 1, \ldots, T \), the existence of a production technology \( S^t \) model that transforms inputs \( x^t \) into outputs \( y^t \). It assumes further that \( S^t \) is sufficiently regular to define meaningful output distance functions. The distance with respect to two different time periods are:

\[
D_0^t(x^{t+1}, y^{t+1}) + \inf\{\Theta: (x^{t+1}, y^{t+1} / \Theta) \in S^t\}
\]

and

\[
D_0^{t+1}(x^t, y^t) + \inf\{\Theta: (x^t, y^t / \Theta) \in S^{t+1}\}
\]

\(^1\) * Equation Numbers Used are Same as in Conceptual Background for the sake of convenience
The first distance function in equation (30) measures the maximum proportionate change in outputs required to make \((x^{t+1}, y^{t+1})\) feasible in relation to the technology at the previous period \(t\). Similarly, equation (31) measures the maximum proportional change in output required to make \((x^t, y^t)\) feasible in relation to the technology at \(t+1\). Based on these, an output based Malmquist productivity can be defined as:

\[
M^D_0 = \frac{D^0_0(x^{t+1}, y^{t+1})}{D^0_0(x^t, y^t)}
\]

\[
M^{t+1}_0 = \frac{D^{t+1}_0(x^{t+1}, y^{t+1})}{D^{t+1}_0(x^t, y^t)}
\]

The Malmquist index can then, according to Fare, Grosskopf, Lindgren and Roos (1989), be arrived at by taking the geometric mean of the two-output based indices in equation (32) and (33) as:

\[
M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \left[ \frac{D^0_0(x^{t+1}, y^{t+1})}{D^0_0(x^t, y^t)} \right]^{\frac{1}{2}} \cdot \left[ \frac{D^{t+1}_0(x^{t+1}, y^{t+1})}{D^{t+1}_0(x^t, y^t)} \right]^{\frac{1}{2}}
\]

Equation 27 can be also re-written as:

\[
M_0(x^{t+1}, y^{t+1}, x^t, y^t) = \frac{D^{t+1}_0(x^{t+1}, y^{t+1})}{D^0_0(x^t, y^t)} \cdot \left[ \frac{D^0_0(x^t, y^t)}{D^{t+1}_0(x^{t+1}, y^{t+1})} \right]^{\frac{1}{2}} \left[ \frac{D^{t+1}_0(x^t, y^t)}{D^0_0(x^{t+1}, y^{t+1})} \right]^{\frac{1}{2}}
\]

Based on equation (30), the efficiency change (EC) and the technical change (TC) can be expressed as:

\[
\text{Efficiency change} = \frac{D^{t+1}_0(x^{t+1}, y^{t+1})}{D^0_0(x^t, y^t)}
\]

\[
\text{Technical change} = \left[ \left( \frac{D^0_0(x^t, y^t)}{D^{t+1}_0(x^{t+1}, y^{t+1})} \right) \left( \frac{D^{t+1}_0(x^t, y^t)}{D^0_0(x^{t+1}, y^{t+1})} \right) \right]^{\frac{1}{2}}
\]

Hence the Malmquist productivity index is simply the product of the change in relative efficiency that occurred between period’s \(t\) and \(t+1\), and the change in technology that occurred between period’s \(t\) and \(t+1\). A value of Malmquist TFP index equal to one implies there has been no change in total factor productivity across the two time periods, greater than one implies an improvement in TFP and a value less than one is interpreted as a regress in TFP. A similar interpretation applies to the two components as well.

2.2.4: (OLS) Ordinary Least Squares Regression Model

The study further for measuring the relationship between agricultural productivity and poverty reduction uses (OLS) ordinary least squares regression model. The effect of agricultural productivity on rural poverty has been measured by
regressing rural poverty on agricultural productivity, assuming linear relationship between these two, and then carrying out statistical significance test on the regression coefficient of agricultural productivity. Thus, we use the linear regression equation

\[ Y = \alpha + \beta Z + \delta X + u \]

Where; \( Y \) = rural poverty level (incidence of rural poverty), \( Z \) = agricultural productivity, \( \beta \) = regression coefficient. \( X \) = control variables, \( \delta \) = regression coefficient and \( u \) = random disturbance term.
3.1: Introduction:

The Five Year Plans pre reform period laid stress on self-sufficiency and self-reliance in food grains production. Concerted efforts in this direction resulted in substantial increase in agricultural production and productivity. This is clear from the fact that from a level of about 52 million tonnes in 1951-52, food grains production rose to above 244.78 million tonnes in 2010-11 (GOI, 2011a). Since early 1990s however liberalization and globalization became core elements of India’s development strategy which had indirect policy implications and impact on Indian agriculture. As part of economic reforms agricultural markets were freed, external trade in agricultural commodities was liberalized and industry was de-protected to create more competition thereby reducing input prices and making terms of trade favourable to agriculture (Singh, 1995). These measures were expected to create a potentially more profitable agriculture, which would be able to bear the economic costs of technological modernization and expansion (Singh, 1995).

The agricultural growth however, started declining with the adoption of economic reforms. The situation worsened in the post WTO (World Trade Organization) period. The growth of agriculture came down from 3.62 in 1990-91 to 1.97 by 2004-05 and the share of agriculture in the gross domestic product registered a steady decline from 36.4 per cent in 1982-83 to 18.5 per cent in 2006-07 (Chand et al., 2007). Moreover, Productivity gains from the Green Revolution technology reached a plateau in many regions, causing per capita food grains production to decline, which had serious implications for food and nutritional security, poverty alleviation, rural development, farm incomes and rural-urban equity. One of the important strategy challenges for faster, sustainable and more inclusive growth (9.0-9.5% growth rate) requires a significant acceleration in growth (4.0 to 4.5% growth rates) in agriculture (GOI, 2011b).

It was argued by the proponents of liberalisation that freeing agricultural markets and liberalising external trade in agricultural commodities would provide price incentives leading to enhanced investment and output in that sector, while broader trade liberalisation would shift inter sectoral terms of trade in favour of agriculture. A decade and a half later, the hollowness of these claims stood exposed (Pillai, 2007 and Patnaik, 2005). This policy option however did not become viable rather it worsened further. The poor performance of agriculture had become a serious
matter of concern and this led to initiation of debates about the causes of agrarian crisis among researchers and policy makers in the country. An attempt is made in this chapter to examine the trend in agricultural growth and factors underlying slowdown in agriculture and explore ways and means to accelerate it. Against this backdrop, this chapter reviews the status and performance of agriculture during the last three decades and also presents what could be the way forward, given the objectives of accelerated growth, inclusiveness and reducing poverty and hunger. The study of this period assumes special significance since it follows the introduction of economic reforms in India in 1991 which brought about fundamental changes in macro-economic and trade policies completely altering the entire agricultural policy framework which had prevailed before 1990’s (Bhalla & Singh, 2010).

3.2: Structural Adjustment and Indian Agricultural

In 1991, faced with a balance of payments crisis, India embarked on an economic reform programme in line with the structural adjustment and stabilization policies initiated by the IMF and World Bank. The economic reforms however did not include any specific package specifically designed for agriculture. It was viewed that freeing agricultural markets and liberalising external trade in agricultural commodities would provide price incentives leading to enhanced investment and output in that sector, while broader trade liberalisation would shift intersectoral terms of trade in favour of agriculture (Balakrishnan, 2000) But by mid-1990s when the World Trade Organization (WTO) was in place, there did unfold many policy reforms directly addressed to agriculture.

Table 3.1 lists some of the important policy changes and measures of economic reform relating to Indian agriculture. International trade in agriculture had been liberalized, beginning in 1997; all Indian product lines had been placed under the Generalized System of Preferences (GSP). By 2000, all agricultural products were removed from quantitative restrictions (QRs) and brought under the tariff system. Canalization of trade in agricultural commodities through state trading agencies was almost removed and most of the products brought under Open General Licensing (OGL). The average tariffs on agricultural products, which stood at over 100 per cent in 1990, were brought down to 30 per cent by 1997 and targeted to come down further.
Table 3.1: Important Measures of Economic Liberalization in Indian Agriculture

<table>
<thead>
<tr>
<th>Area of Liberalization</th>
<th>Policy Changes and Measures of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>External Trade Sector</strong></td>
<td>a. In tune with the WTO regime, since 1997 all Indian product lines placed in GSP.</td>
</tr>
<tr>
<td></td>
<td>c. Average tariffs on agricultural imports reduced from 100 per cent in 1990 to 30 per cent in 1997.</td>
</tr>
<tr>
<td></td>
<td>d. Though India is in principle against Minimum Common Access, but actually already importing 2 per cent of its food requirements.</td>
</tr>
<tr>
<td><strong>Internal Market Liberalization</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. More liberalized imports of seeds.</td>
</tr>
<tr>
<td>3. Power</td>
<td>a. Since 1997, power sector reforms were introduced at the behest of the World Bank in states such as Andhra Pradesh and power charges increased.</td>
</tr>
<tr>
<td></td>
<td>b. Power sector opened to the private sector.</td>
</tr>
<tr>
<td>4. Irrigation</td>
<td>a. Water rates increased in some states.</td>
</tr>
<tr>
<td></td>
<td>b. Participatory water management was sought to be introduced through water users' associations (WUAs).</td>
</tr>
<tr>
<td></td>
<td>c. States such as Andhra Pradesh made new large irrigation projects conditional on 'stakeholder' contribution to part of investment.</td>
</tr>
<tr>
<td>5. Institutional Credit</td>
<td>a. Khursro Committee and Narasimham Committee (1992) undermining the importance of targeted priority sector landing by commercial banks.</td>
</tr>
<tr>
<td></td>
<td>b. The objectives of regional rural banks' (RRBs) priority to lending to weaker sections in rural areas diluted since 1997.</td>
</tr>
<tr>
<td></td>
<td>b. Relaxation of restrictions on the inter-state movement of farm produce.</td>
</tr>
<tr>
<td></td>
<td>d. Encouragement of contract farming.</td>
</tr>
<tr>
<td></td>
<td>e. Agricultural commodity forward markets.</td>
</tr>
<tr>
<td>Fiscal Reforms</td>
<td>a. Fiscal reforms with an emphasis on tax reduction and public expenditure turned to reducing fiscal deficit as priority (grave implications for public investment in agriculture and rural infrastructure).</td>
</tr>
</tbody>
</table>

Source: Radhakrishna (2008)
As a part of economic reforms agricultural markets were freed, external trade in agricultural commodities was liberalized and industry was de-protected to create more competition thereby reducing input prices and making terms of trade favourable to agriculture. These measures were expected to create a potentially more profitable agriculture, which would be able to bear the economic costs of technological modernization and expansion (Singh, 1995). The terms of trade between Indian agriculture and industry however worked against agriculture through the mid-1980s but turned in favour of agriculture since the early 1990s (Landes and Gulati, 2003).

But despite these changes in the macroeconomic policy framework and trade liberalisation, the agricultural sector in India neither experienced any significant growth subsequent to the initiation of economic reforms in 1991 nor did it derive the expected benefits from trade liberalisation. As a matter of fact, when compared with the immediate pre-liberalisation period (1980-83 to 1990-93), agricultural growth in India recorded a visible deceleration during the post-liberalisation period (1990-93 to 2003-06) (Ballah and Singh, 2009). Although the reforms improved terms of trade in favour of agriculture but growth in agricultural sector had fallen short of targets and was well below that of non-agricultural sectors. Further the gap between rural and urban incomes had widened. Productivity gains from the Green Revolution technology reached a plateau in many regions, causing per capita food grains production to decline, which had serious implications for food and nutritional security, poverty alleviation, rural development, farm incomes and rural-urban equity (Sharma, 2011). Another significant development in the post reform period was the commercial introduction of genetically modified cotton seed varieties in 2002 by the multinational corporation, Monsanto.

The removal of (QRs) under WTO led to progressive removal of the insulation of the domestic agricultural prices from the global market prices, making peasantry vulnerable to world market price fluctuations. Further there was an actual secular downtrend in the agricultural commodity prices in the world market from 1995 onwards. This had its impact on the Indian producers (Patnaik, 2007). One problem with trade was that volatility in domestic agricultural prices would increase with globalization. Several studies showed that volatility in global prices was higher than domestic commodity prices (Nayyar and Sen, 1994; Chand and Jha, 2001). In a closed
economy, lower output is normally accompanied by some price increase. With liberalization, we had a situation of lower production with lower prices. This pattern reflected the effect of the growing integration of Indian agriculture with world markets, resulting from trade liberalisation. There was a need for extreme vigilance so as to be able to take timely measures, within the existing tariff bindings to arrest heavy import of certain commodities (Rao, 2005).

Domestically the structural adjustment programme (SAP) initiated in year 1991 had wide ranging implications for Indian agriculture. The fiscal reforms as a part of wider economic reforms programme led to upward thrust in the input prices for the peasantry. “The single minded pursuit of fiscal reforms had much greater effect on the agricultural input support system and institutions than even the provision of Agreement on Agriculture (AOA) of WTO” (Reddy and Mishra, 2009). In terms of fiscal policies, the reduced spending of central and state governments was the most significant feature in the 1990s. Due to tax reforms, the tax/GDP ratio declined at central level. Central transfers to state governments also declined. The Green Revolution of 1960s was a turnaround moment for Indian agriculture.

This new form of agriculture was however strongly backed by the state. Where by state vigorously helped farmers to adopt new agriculture technology by making various inputs easily available as the new practice was input based and was totally different from conventional practices which were based on domestic or owned inputs. The state subsidised seeds (The National Seed Corporation was established in 1963), fertilizers, electricity provided rural infrastructure in the form of irrigation canals and roads. Credit was made available to farmers on priority bases this was possible through bank nationalization of 1969. A network of Agricultural Universities was set up under Indian Council of Agricultural Research, to promote R&D in agriculture.

One of the most important factors responsible for the success of Green Revolution was increase in institutional credit to agriculture since bank nationalization in 1969. As a fall out of 1991 policies, bank credit to agriculture started to dry up. The Narasimham Committee on Financial Reforms (1992) recommended the dilution of priority sector lending, including lending to the agricultural sector by the commercial banks. Though priority lending to agriculture was not removed, the insistence on adherence to commercial performance placed a
severe constraint on bank credit to agriculture, with disastrous consequences. Instead of an expansion in rural bank branches, there was actually closure of such branches, which declined from 34,867 in 1990 to 32,386 in 2003 (Rao, 2004). The Regional Rural Banks (RRBs), which were meant for lending specifically to ‘weaker sections’, were opened to all on commercial principles, with upward revision of interest rates (Rao, 2004). With the result the agricultural sector has increasingly turned to money lenders and traders for loans, where the interest rates were exorbitant. The charge varied from 36 per cent to 60 per cent.

Fertilizers are another important input. Subsidy on fertilizers had been considerably reduced post 1991. Fertilizer subsidy, which amounted to 3.2 per cent of GDP and 6 per cent of the Union revenue expenditure in 1990–1, was reduced to 2.5 per cent and 5 per cent, respectively by 1997–8 (Acharya, 2004). It was further reduced to 0.69 per cent of GDP by 2003–4 (Sen and Bhatia, 2004). With the result the cost of fertilizers increased. Reforms in power sector resulted in increase in the cost of power for the peasantry substantially at the same time petroleum prices increased significantly thus adding fuel to fire. As part of irrigation reforms many states revised the water rates upwards with the objective of recovering operation and maintenance costs. Some states like Andhra Pradesh had announced a ban on investment in new major irrigation projects, unless the ‘stakeholders’ also contributed to part of the investment. The irrigation reforms included introduction of participatory water management through Water Users’ Associations (WUAs), which did not have much impact on the efficiency of utilization of irrigation water resources. The Steering Committee report on agriculture for 11th Plan (GOI, 2007b) identified the possible reasons for deceleration in agriculture since mid-1990s. According to the report, the major sources of agricultural growth are: public and private investment in agriculture and rural infrastructure including irrigation, technological change, diversification of agriculture and fertilizers. It is evident that there has been a significant decline in the allocation of public outlay on agriculture as a per cent of total public outlay during the post-reforms period compared to what it was in pre-reforms period (Desai and Namboodiri, 1997).

3.3 Share of Agriculture in India’s Gross Domestic Product

The agriculture sector in India underwent significant structural changes; its share in GDP decreased from 35.69 per cent in 1980-81 to 14.01 per cent in 2011-12.
indicating a shift from the traditional agrarian economy towards an economy dominated by services (Fig 3.1). This decrease in contribution of agriculture to GDP was not accompanied by a matching reduction in the share of agriculture in employment. About 52% of the total workforce was still employed by the farm sector which makes more than half of the Indian population dependant on agriculture for sustenance (NSSO, 2010).

**Fig 3.1: Sectoral Composition of GDP**

![Graph showing sectoral composition of GDP](image)

*Source: Handbook of Statistics on the Indian Economy, RBI (2011-12).*

The declining share of agriculture to GDP, continuing high pressure of population on agriculture and increasing fragmentation of land holdings has led to decreasing availability of cultivated land area per household. In such circumstances, agriculture sector would hardly be in a position to create additional employment opportunities to sustain the livelihood of rural households. Thus there is a need for creation of additional employment opportunities in non-farm and manufacturing sectors, especially, in agro-based rural industries which have area specific comparative advantage in terms of resources endowment and development possibilities (SIA, 2011-12). This would require suitable skill development of the people so as to gainfully employ them in non-farm activities. This alone would be able to make agriculture viable in a sustainable manner. In addition, by creating more
employment in non-farm sector and absorbing some of the surplus labour in agriculture, this will contribute to achieving our objective of inclusive growth (SIA, 2011-12).

3.4: Growth Performance of Agriculture

The growth performance of agriculture sector had fluctuated in different five year plans (Fig 3.2) with an impressive 5.8 per cent growth rate during the sixth plan (1980-85). The agriculture sector however saw a downturn towards the beginning of early nineties with a negative growth rate of 2 per cent during the annual plan of 1991-92. With an improved performance it witnessed a growth rate of 4.8 per cent during the Eighth plan period (1992-97). But a lower rate of growth (2.5 per cent) during the Ninth plan period (1997-2002) which fell further to 2.4 per cent during the Tenth plan period (2002-07). Growth rate of agriculture and allied sectors bounced back during the eleventh plan 3.3 per cent although less than the targeted growth rate of 4 per cent. Agricultural growth during 1990-93 to 2003-06 reflects the impact of economic reforms on agricultural performance (Bhalla and Singh, 2009). The most important feature of this period was that agricultural growth decelerated sharply at all India level and in all regions.

Fig 3.2: Growth Rate - GDP (overall) and GDP (Agriculture & Allied Sectors)

With the output growth decelerating to 1.74% pa during 1990-93 to 2003-06 compared with a growth rate of 3.37% pa during 1980-83 to 1990-93 at all-India
The main reason for the deceleration of growth during the post reform period was a visible deceleration in investment in irrigation and other rural infrastructure (Bhalla and Singh, 2009). This crippling growth rate of 2.4 per cent in agriculture as against a robust annual average overall growth rate of 7.6 per cent for the economy during the tenth plan period was clearly a cause for concern. The increasing divergence between the growth trends of the total economy and that of agriculture and allied sectors suggests an under performance by agriculture (Fig 3.3). Agricultural GDP growth has accelerated to an average 3.9 per cent during 2005-06 to 2010-11. The Eleventh five year Plan had sought to reverse the deceleration of agricultural growth which occurred in the Ninth Plan and continued into the Tenth Plan. It had some success as food grain production touched a new peak of 250.42 million tonnes in 2011-12 and average annual growth rate during the Eleventh Plan was 3.3 per cent which is much better than last two plans though less than targeted 4 per cent growth rate (SAI, 2011-12). Unlike the overall economic growth pattern, agricultural performance in India has been quite volatile the coefficient of variation during 1991 to 2011 was 140.66 compared to 134.48 during 1980-1990. This was quite high compared to CV observed in the overall GDP growth of the country which stood at 38.8 during 1980 to 1990 and 31.5 during 1991 to 2011 indicating high and increasing volatility which was a real challenge in the wake of climate change.

**Fig 3.3: Comparative Performance of Growth of overall GDP and Agricultural GDP 1980-81 to 2011-2012**

3.5: Crop Specific Growth

Acreage and yield were the sources of growth in the production of agricultural crops. Given the obvious limitations in expansion of agricultural land, long-term growth primarily depends on improvement in yields. An analysis of trends in indices of area, production, and yield indices of different crops during the period 1980-81 to 2009-10 is given in (Table 3.2).

Rice and Wheat:

During the decade of 1980s, although growth in area under rice was marginal at 0.41 per cent only, however, growth in production and yield was above 3 per cent. During 2000-01 to 2009-10 the situation changed, whereas growth in area was negative at -0.02 per cent, the growth in production and yield also declined at 1.59 per cent and 1.61 per cent respectively in comparison to what was achieved during the preceding decade. In case of wheat, during 1980s growth in area was marginal at 0.45 per cent but growth in production and yield was above 3 per cent. During 2000-01 to 2011-12, although growth in area under wheat was 1.20 per cent, better than the previous decade, growth in production and yield was 1.90 per cent and 0.69 per cent respectively. Clearly reflecting that yield levels have plateaued for these crops and there is need for renewed research efforts to boost production and productivity (SAI, 2011-12).

Coarse cereals:

Area under coarse cereals displayed a negative growth during all the three periods reflecting either shift to other crops or relatively dry areas remaining fallow. The growth in production and yield which was 0.35 per cent and 1.71 per cent respectively in the 1980s underwent marginal changes during the decade of 1990’s with production becoming worse at -0.01 per cent and yield increasing marginally at 2.14 per cent. But the figures have improved significantly to 2.39 per cent and 3.18 per cent for production and yield respectively in the 2000-01 to 2009-10 periods. This increase was primarily driven by rise in production and yield of Maize and Bajra. It also reflects growing popularity of coarse cereals as nutri food (GOI, 2012).
Table 3.2: All India Average Annual Growth Rates of Area, Production and Yield of Principal Crops (Per cent)

<table>
<thead>
<tr>
<th>CROPS/CROP GROUPS</th>
<th>1980-81 to 1989-90</th>
<th>1990-91 to 1999-00</th>
<th>2000-01 to 2009-10</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>P</td>
<td>Y</td>
</tr>
<tr>
<td>RICE</td>
<td>0.41</td>
<td>3.61</td>
<td>3.19</td>
</tr>
<tr>
<td>WHEAT</td>
<td>0.45</td>
<td>3.58</td>
<td>3.11</td>
</tr>
<tr>
<td>MAIZE</td>
<td>-0.17</td>
<td>1.91</td>
<td>2.10</td>
</tr>
<tr>
<td>COARSE CEREALS</td>
<td>-1.33</td>
<td>0.35</td>
<td>1.71</td>
</tr>
<tr>
<td>GRAM</td>
<td>-1.42</td>
<td>-0.79</td>
<td>0.64</td>
</tr>
<tr>
<td>TUR</td>
<td>2.31</td>
<td>2.86</td>
<td>0.54</td>
</tr>
<tr>
<td>TOTAL PULSES</td>
<td>-0.10</td>
<td>1.49</td>
<td>1.59</td>
</tr>
<tr>
<td>TOTAL FOODGRAINS</td>
<td>-0.23</td>
<td>2.73</td>
<td>2.97</td>
</tr>
<tr>
<td>GROUNDNUT</td>
<td>1.64</td>
<td>3.76</td>
<td>2.08</td>
</tr>
<tr>
<td>R &amp; M</td>
<td>1.95</td>
<td>7.29</td>
<td>5.25</td>
</tr>
<tr>
<td>SOYABEAN</td>
<td>17.11</td>
<td>18.06</td>
<td>0.62</td>
</tr>
<tr>
<td>NINE OILSEEDS</td>
<td>2.44</td>
<td>5.45</td>
<td>2.95</td>
</tr>
<tr>
<td>SUNFLOWER</td>
<td>25.62</td>
<td>20.90</td>
<td>-3.48</td>
</tr>
<tr>
<td>SUGARCANE</td>
<td>1.46</td>
<td>2.71</td>
<td>1.23</td>
</tr>
<tr>
<td>COTTON</td>
<td>-1.26</td>
<td>2.80</td>
<td>4.10</td>
</tr>
<tr>
<td>BAJRA</td>
<td>-1.05</td>
<td>0.02</td>
<td>1.07</td>
</tr>
<tr>
<td>JOWAR</td>
<td>-1.00</td>
<td>0.28</td>
<td>1.29</td>
</tr>
<tr>
<td>JUTE &amp; MISTA</td>
<td>-2.83</td>
<td>0.14</td>
<td>3.10</td>
</tr>
<tr>
<td>MASUAR</td>
<td>1.99</td>
<td>5.49</td>
<td>3.43</td>
</tr>
</tbody>
</table>

Source: Directorate of Economics & Statistics, Ministry of Agriculture

Note A: Area, P: production, Y: Yield

Pulses:

During the 1980s there was negative growth in area of total pulses and growth in production and yield was 1.49 per cent and 1.59 per cent respectively. During the period 2000-01 to 2009-10, the indices of area, production and yield of pulses grew by 1.16 per cent, 2.71 per cent, and 1.53 per cent respectively. Gram and Tur were the major contributors to total production of pulses in the country. The growth in indices of area and production during 2000-01 to 2009-10 was mainly on account of Gram, it recorded a growth of 5.98 per cent in production during this period.
Oilseeds:

The indices of yield and area under oilseeds showed improvement in annual growth during the years 2000-01 to 2009-10 compared to the decade of 1980s. Soyabean recorded a high rate of growth in production in both the periods, driven primarily by expansion in area under cultivation. While Rapeseed and Mustard and Sunflower recorded a high growth rate during the last decade, the biggest increase in the growth rates of production and yield during the last decade was in cotton.

Cotton:

Cotton has experienced significant changes with the introduction of Bt Cotton. Bt cotton cultivation increased yields in most areas and at the same time reduced pesticide sprays. The combined cost savings from reduced pesticide use and increased yields thus increased profits for farmers (IFPRI, 2008).

3.6: Capital Formation

The share of gross capital formation (GCF) of agriculture and allied sectors in total GCF consistently decreased from early eighties when it was 18 to 20 per cent to 5 to 6 per cent during the year 2007-08 (Fig 3.4).

Fig 3.4: Share of Public, Private and Total GCF in Agriculture and Allied Sectors to Total GCF

Both the public as well as private GCF followed a similar trend. Though private GCF showed fluctuations, increasing during some of the years, Public GCF regularly decreased throughout the entire period. There was a significant decline in the allocation of public outlay on agriculture as a per cent of total public outlay during the post-reforms period compared to that in pre-reforms period (Desai and Namboodiri, 1997). This decrease indicated that the non-agriculture sectors received higher investment as compared to agriculture and allied sector over the plan periods resulting in growth disparities. Though this was in line with the overall falling share of agriculture in the overall GDP, and also conformed to the development process observed elsewhere in the developing world, yet keeping in view the high population pressure on agriculture for their sustenance, there was need for substantial increase in investment in agriculture (SAI, 2011-12).

The GCF in agriculture and allied sector as percentage of agricultural GDP followed a declining trend during eighties and early post reform period. GCF however, increased to 20.1 per cent in 2010-11 from 13.5 per cent in 2004-05 at 2004-05 prices (GOI, 2012). Thus, as a percentage of agricultural GDP, the GCF in agriculture has more than doubled during the last decade. Yet, the agriculture GDP growth did not accelerate commensurately, though in Eleventh Five Year Plan it showed improvement over the growth rates achieved in the Ninth and Tenth Five Year Plans.

Plan wise public expenditure on agriculture, irrigation and flood control as per cent of total public expenditure from sixth plan to Eleventh Plan is given in table 3.3. It is observed that the share of public expenditure on agriculture and allied sectors declined from about 6 per cent in 6th Plan to about 4.5 per cent in 10th plan. Irrigation, which is a leading input for agricultural growth, expenditure also witnessed a declining trend (10% in Sixth plan to about 8% in Tenth plan). The share of public sector expenditure under rural development in total expenditure increased from 6.4 per cent in the Sixth plan to 9.2 per cent in the Tenth plan. The expenditure on food and fertilizer subsidies has also increased significantly from 6.7 per cent in Seventh plan to about 17.1 per cent in Eleventh plan. During the 11th Plan there was 124% increase in public sector resources allocated for agriculture and allied activities, from Tenth Plan realization level of Rs.60,702 crore, to Rs. 1,36,381 crore (at 2006-07 prices) by the Centre, States and UTs with share of Centre being 50,924
Rashtriya Krishi Vikas Yojana, in the form of 100% grant-in-aid, was launched in the 11th Five-Year Plan with a projected allocation of Rs. 25,000 crore over and above the other on-going programmes to incentivize the States to make higher investment in agriculture. The RKVY, which provides sufficient flexibility to the States to take into account local needs, has helped in increasing allocation to agricultural sector. Since public participation is highly essential for successful implementation of agricultural development programmes, people's involvement in the development endeavours will help in promoting the bottom up approach of planning process and also help in faster diffusion of the technologies and best practices among farmers, community based actions and participation of disadvantaged sections of the society in developmental process.

Table 3.3: Profile of Public Expenditure (% to Total Public Expenditure) on Agriculture, Irrigation and Flood Control and Rural Development since Sixth Five Year Plan

<table>
<thead>
<tr>
<th></th>
<th>6th Plan</th>
<th>7th Plan</th>
<th>8th Plan</th>
<th>9th Plan</th>
<th>10th Plan</th>
<th>11th Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture &amp; allied sector</td>
<td>6.1</td>
<td>5.8</td>
<td>5.1</td>
<td>4.5</td>
<td>4.5</td>
<td>4.4</td>
</tr>
<tr>
<td>Rural development</td>
<td>6.4</td>
<td>7.0</td>
<td>8.3</td>
<td>6.9</td>
<td>9.2</td>
<td>9.0</td>
</tr>
<tr>
<td>Irrigation &amp; flood control</td>
<td>10.0</td>
<td>7.6</td>
<td>6.5</td>
<td>7.7</td>
<td>8.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Agriculture, irrigation &amp; flood control and rural development</td>
<td>23.9</td>
<td>22.0</td>
<td>20.9</td>
<td>19.9</td>
<td>23.0</td>
<td>21.8</td>
</tr>
<tr>
<td>Agriculture research &amp; education (% of total agri. &amp; allied sector)</td>
<td>9.6</td>
<td>6.7</td>
<td>5.2</td>
<td>10.4</td>
<td>12.0</td>
<td>15.9</td>
</tr>
<tr>
<td>Food &amp; fertilizer subsidy (% of total expenditure)</td>
<td>7.7</td>
<td>11.0</td>
<td>10.5</td>
<td>11.8</td>
<td>16.3</td>
<td>17.1</td>
</tr>
</tbody>
</table>

Source: Sharma (2011)
plan periods. However, public spending on agriculture research, education, and extension is about 0.6-0.7 per cent of agricultural GDP (Chand, et. al., 2011), which is much lower than the international norm of 2 per cent. These would require a big jump in allocation of budget for the agriculture and allied sectors both at the central and State government levels in total public spending. The public expenditure for technology-led agricultural growth must be prioritized in favour of agricultural research and education including extension; irrigation and flood control; soil and water conservation; rural infrastructure, rural financial institutions, and rural development and poverty alleviation programmes for creating community assets that directly contribute to agricultural growth.

3.7: Irrigation

Availability of sufficient amount of water is essential for the success of agriculture. In the Indian countryside, no single factor makes more of a difference between prosperity and despair than water. Areas with good and controlled water supplies are verdant and productive; those without it are barren or subject to the vagaries of the monsoons. Irrigation systems have transformed the landscape, extending cultivation into more areas, with higher intensity and yields (Gulati et al., 2005). The Government of India has taken up augmentation of irrigation potential through public funding and is assisting farmers to create potential on their own farms. Substantial irrigation potential has been created through major and medium irrigation schemes (Kumbhar, 2011). There is no doubt that the overall size, quality, and efficiency of investment are always the key drivers of growth in any sector. In case of public investments in agriculture, as defined in the National Accounts Statistics, more than 80 per cent is accounted for major and medium irrigation schemes. Even in the case of private investments in agriculture, almost half is accounted for by irrigation (minor, primarily through groundwater, but also now increasingly drip, etc.). So irrigation remains the most dominant component in the overall investment in agriculture. Without proper use of water, it is difficult to get good returns on better high yielding seeds and higher doses of fertilizers (SIA, 2011-12).
Net irrigated area has increased from around 38 million hectares in 1980-81 to over 63 million hectares by 2008-09 (about 45 per cent of NSA). Gross irrigated area increased at faster rate from about 49 million hectares to 88.4 million hectares due to increased intensity of cropping on irrigated lands (Fig. 3.5). The development of tube-well irrigation, supported by investment in electrification and credit provision, has been the main driving force behind irrigation expansion in the country, particularly in the northwest (Sharma, 2011). As a result of this, the share of tube wells in net irrigated area increased from less than 3 per cent in early 1960s to 41.8 per cent in TE 2008-09. On the other hand, surface irrigation (canals plus tanks) which accounted for about 58 per cent of NIA in the TE 1953-54 was now estimated to contribute less than 30 per cent. The share of tanks declined very significantly from 16.5 per cent to 3.2 per cent during the same period (Sharma, 2011).

In spite of large investments and increase in area under irrigation, the performance of many irrigation systems was significantly below potential due to inadequate design, use of inappropriate technology, inappropriate government policies, and poor management practices. The water use efficiency in India was estimated to be about 38-40 per cent for canal irrigation and about 60 per cent for ground water irrigation. Agriculture, being the major water user, its share in the total demand was bound to decrease due to competing demands from other sectors.
(Sharma, 2011). Therefore, improving water use efficiency is of great significance. It is estimated that with 10 per cent increase in the present level of water use efficiency in irrigation projects, an additional 14 million hectares area can be brought under irrigation from the existing irrigation capacities which would involve a very moderate investment as compared to the investment that would be required for creating equivalent potential through new schemes (GOI, 2007b). It is, therefore, important to ensure active participation of farmers in irrigation management and that would improve the performance and sustainability of irrigation systems.

Another problem associated with irrigation is uneven distribution of irrigated areas among different states. The extent of irrigation (both in absolute terms and relative to cultivated area) has increased in all states. While Punjab 97 per cent, Haryana 85, Uttar Pradesh 74 per cent, Bihar 58 per cent, Tamil Nadu 57 per cent and West Bengal 56 per cent have more than half of the cropped area under irrigation, Odissa, Rajasthan, Madhya Pradesh, Karnataka, Chhattisgarh, Himachal Pradesh, Maharashtra, Kerala, Jharkhand and Assam have very low acreage under irrigation (Fig 3.6).

**Fig 3.6: State Wise Irrigation Coverage in 2006-07**

(Per cent)

<table>
<thead>
<tr>
<th>States and All India</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of Irrigated Cropped area</td>
</tr>
<tr>
<td>120</td>
</tr>
<tr>
<td>100</td>
</tr>
<tr>
<td>80</td>
</tr>
<tr>
<td>60</td>
</tr>
<tr>
<td>40</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>

**Source:** Directorate of Economic and Statistics
3.8: Fertilizer Consumption

Chemical fertilizers have played a significant role in the development of the agricultural sector. Consumption of nitrogenous (N), phosphatic (P) potassic (K) fertilizers have increased from 1.1 million tonnes in 1966-67, the year preceding the green revolution to 27.7 million tonnes in 2011-12. The all-India average consumption of fertilizers has increased from 105.5 kg per ha in 2005-06 to 144 kg per ha in 2011-12. However, our consumption is much lower than that in Bangladesh (118 kg), Pakistan (205 kg) and China (396 kg). The world average consumption of fertilizer was 107 kg per hectare in 2009 (SIA, 2012-13).

India is the second largest consumer of fertilizers in the world after China, consuming about 26.5 million tonnes (Jagga and Patel, 2012). However compared with more than 100% growth in fertilizer consumption during the pre-reform period its growth was just 50% over the post reform period (table 3.4). The all India annual growth rate of fertilizer consumption has decreased from 8.08 per cent during the decade of 80’s to 4.01 per cent from 1990-91 to 2010-11. India is meeting 80 per cent of its urea requirement through indigenous production but is largely import dependent for meeting the requirements of potassic (K) and phosphatic (P) fertilizers (Economic Survey, 2011-12). Figure 3.7 shows the growth rate of consumption of fertilizers in India during the period 1980-81 to 2010-11.

Fig 3.7: All India Nitrogen, Phosphate and Potassium (NP&K) Consumption (Thousand Tonnes)

Source: Department of Agriculture & Cooperation
Although average intensity of fertilizer use in India remains much lower than most countries in the world but is highly skewed with wide inter-regional, inter-state and inter-district variations further non-price factors such as irrigation, high yielding varieties were more important than price factors in influencing demand for fertilizers (Jagga and Patel, 2012). One of the major constraints to fertilizer use efficiency in India is imbalance of applied nutrients. Nitrogen (N) applications tend to be too high in relation to the amount of potassium (K) and phosphate (P) used. This is partly the result of a difference in price of different nutrients, and partly due to the lack of knowledge among farmers about the need for balanced fertilizer applications (Sharma and Thaker, 2010). The NPK ratio shows wide inter-regional and inter-state disparity. While existing variation from the ideal ratio (4:2:1) was nominal in the South (2.6:1.3:1.0) and the Eastern region (3.0:1.3:1.0), it was very wide (16.9:15.4:1.0) in the North in 2008-09 (Sharma and Thaker, 2010). It is apparent that an integrated nutrient management approach is required to enable a balanced use of fertilizers for optimum results. Also, the setting up of adequate capacity for soil testing needs to be continued.

Table 3.4: All India Annual Growth Rate of Fertilizer Consumption (CAGR)

<table>
<thead>
<tr>
<th>Years</th>
<th>1980-81 to 1989-90</th>
<th>1990-91 to 1999-00</th>
<th>2000-01 to 2010-11</th>
<th>1990-91 to 2010-2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAGR</td>
<td>8.084383</td>
<td>4.408711</td>
<td>5.951023</td>
<td>4.017351</td>
</tr>
</tbody>
</table>

*Source: Department of Agriculture & Cooperation*

3.9: Agricultural Credit

A big challenge for sustaining food self-sufficiency is raising production which, given that available land is fixed if not diminishing, has to come from improved productivity. A host of cash and non-cash inputs is necessary to improve productivity, and an important one is agricultural credit (Rao, 2012). The importance of farm credit as a critical input to agriculture is reinforced by the unique role of Indian agriculture in the macroeconomic framework and its role in poverty alleviation (Golait, 2007). Development experience shows that credit is an important determinant of value added in agriculture. A quick assessment by the Reserve Bank of the relationship between institutional credit to agriculture evidences positive and
statistically significant elasticity – every one per cent increase in real agricultural credit results in an increase in real agricultural GDP by 0.22 per cent with a one-year lag. Further, the Granger causality test also indicates that the causality was unidirectional from agricultural credit to agricultural GDP (Rao, 2012). The demand for agricultural credit arises due to i) lack of simultaneity between the realisation of income and act of expenditure; ii) lumpiness of investment in fixed capital formation; and iii) stochastic surges in capital needs and saving that accompany technological innovations (Golait, 2007). The success of Indian agriculture to quite an extent therefore depended on institutional credit.

3.9.1: Changing Access & Availability of Credit to Agriculture and Rural Areas

The financial sector liberalization led to weakness of institutional framework for agricultural credit. Prior to liberalization credit was made available to farmers on priority bases since Nationalization of Banks in 1969 as a fall out of 1991 policies. Institutional credit to agriculture started drying up. The Narasimham Committee on Financial Reforms (1992) recommended the dilution of priority sector lending, including lending to agricultural sector by commercial banks. Though priority lending to agriculture was not removed, the insistence on adherence to commercial performance placed a severe constraint on bank credit to agriculture, with disastrous consequences. Instead of an expansion in rural bank branches, there was actually closure of such branches, which declined from 34,791 in 1990 to 30,188 in 2006 (Appendix 1). The regional rural banks (RRBs), which were meant for lending specifically to ‘weaker sections’, were opened to all on commercial principles, with upward revision of interest rates (Rao, 2004). With the result the agricultural sector increasingly turned to money lenders and traders for loans. These non-institutional sources however charge very high interest rates (GOI, 2007).

The negative impact of the post-1991 policies can be further observed from (Appendix 2). Credit to agriculture as a proportion of total bank credit of commercial banks decreased from 15 per cent in 1990-91 to 11.8 per cent in 1999-2000 with a fractional recovery to 12.2 per cent in 2011-12. The percentage of small borrowal accounts below Rs. 25,000 which can be treated as a proxy for extensiveness of credit flow to priority sectors shrunk from 21.90 per cent in 1992-93 to 10.01 per cent in 1999-2000 and further to 1.30 in 2010-11. Similarly percentage of advances ranging between Rs. 25,000 and Rs. 2 Lakhs followed a declining trend, peaking around
2000-01 at 14.42% and then falling to 9.48% during 2010-11. The rural credit-deposit (CD) ratio which was 58.72 per cent in 1991-92 fell to 40.1 per cent in 2000-01, though it recovered to 49.87 per cent in 2004-05 and 72.33 per cent in 2011-12. It appears that the RBI and government view that the development of financial markets is sufficient to take care of credit needs of agriculture and rural sector. But financial markets fail the poor – whether farmers or micro-entrepreneurs.

3.9.2: Performance of Cooperatives

In the multi-agency approach, apart from commercial banks, financial services are provided to the rural sector by the co-operative banking system and the RRBs. In the aftermath of reforms and adherence to the Basel standards of capital adequacy, income recognition and asset classification, the cooperative banking system is a major provider of financial services to the rural sector. On the credit front, the functioning of the rural cooperative credit institutions deteriorated in many parts of the country. The emphasis on economic efficiency led to the neglect of social priorities in lending by the Commercial and Regional Rural Banks. Targeted and priority lending are under pressure. The result is growing dependence on non-institutional sources of credit available at very high rates of interest (GOI, 2007).

Table 3.5: Declining Share of Cooperatives in Direct Institutional Credit (Loans Issued) to Agriculture and Allied Activities (Short-Term and Long-Term)

<table>
<thead>
<tr>
<th>Years</th>
<th>Total Credit to Agriculture (Rs. in Billion)</th>
<th>Share of Cooperatives (Rs. in Billion)</th>
<th>Share Cooperatives (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-81</td>
<td>34.36</td>
<td>20.29</td>
<td>59.0</td>
</tr>
<tr>
<td>1990-91</td>
<td>101.82</td>
<td>48.19</td>
<td>47.3</td>
</tr>
<tr>
<td>2004-05</td>
<td>1053.03</td>
<td>450.09</td>
<td>42.7</td>
</tr>
<tr>
<td>2008-09</td>
<td>2459.76</td>
<td>587.87</td>
<td>23.8</td>
</tr>
</tbody>
</table>


The loss as a result of a decade of inaction had been costly for the cooperative banking sector, weakening a large part of the system. The outcome of this systematic atrophy was that the share of cooperatives in agricultural credit consistently dropped, from a share of 59.0 per cent of total credit to agriculture in 1980-81, witnessed the decline of that to 42.7 per cent in 2004-05 and further to 23.8 per cent of the total agricultural credit in 2008-09 (Table 3.5). Further the overall condition of the rural
cooperative network is not very good (Table 3.6) gives a broader picture of the Rural Cooperative Credit System as on March 31, 2005. The number of loss making units increased substantially at every stage of the rural cooperatives network, being highest at 40,388 for PACS, in addition to high accumulated losses (Table 3.6).

Table 3.6: Health of Rural Cooperative Credit System (as on March 31, 2005)

<table>
<thead>
<tr>
<th>Institution</th>
<th>No of units</th>
<th>No of loss making units</th>
<th>Percentage of loss making units</th>
<th>Total accumulated losses (Rs crore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>State cooperative banks (SCBs)</td>
<td>31</td>
<td>6</td>
<td>19.35</td>
<td>267.91</td>
</tr>
<tr>
<td>District central cooperative banks (DCCBs)</td>
<td>367</td>
<td>79</td>
<td>21.52</td>
<td>4,793.99</td>
</tr>
<tr>
<td>Primary agricultural cooperative credit societies (PACS)</td>
<td>1,08,779</td>
<td>40,388</td>
<td>37.12</td>
<td>6,862.43</td>
</tr>
<tr>
<td>State cooperative agriculture and rural development banks (SCARDBs)</td>
<td>20</td>
<td>9</td>
<td>45</td>
<td>1,098.43</td>
</tr>
<tr>
<td>Primary cooperative agriculture and rural development banks (PCARDB)</td>
<td>727</td>
<td>472</td>
<td>64.92</td>
<td>2,474.97</td>
</tr>
</tbody>
</table>


3.9.3 Changing Composition of Source Wise Share of Debt

As per the All-India Debt and Investment Survey (AIDIS), 2002, the share of non-institutional sources in the debt of cultivator households increased from 30.6% in 1991 to 38.9% in 2002 (Table 3.7), reversing some of the positive achievements made during 1980s. According to the Report of the Expert Group on Agricultural Indebtedness (2007) a more worrying feature of the trend was the increase in the share of moneylenders in the total debt of cultivators from 17.5 per cent to 26.8 per cent during the same period. The report also observed that there was an inverse relationship between land-size and the share of debt from informal sources. Moreover, a considerable proportion of the debt from informal sources was incurred at a fairly high rate of interest. About 36 per cent of the debt of farmers from informal sources had interest ranging from 20 to 25 per cent. Another 38 per cent of loans had been borrowed at an even higher rate of 30 per cent and above, indicating the excessive interest burden of such debt on small and marginal farmers.
Table 3.7: Source wise Share of Debt of Cultivator Households: 1951-2002

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional</td>
<td>7.3</td>
<td>18.7</td>
<td>31.7</td>
<td>63.2</td>
<td>66.3</td>
<td>61.1</td>
</tr>
<tr>
<td>Cooperative Societies/ Banks, etc</td>
<td>3.3</td>
<td>2.6</td>
<td>22.0</td>
<td>29.8</td>
<td>30.0</td>
<td>30.2</td>
</tr>
<tr>
<td>Commercial banks</td>
<td>0.9</td>
<td>0.6</td>
<td>2.4</td>
<td>28.8</td>
<td>35.2</td>
<td>26.3</td>
</tr>
<tr>
<td>Non-Institutional</td>
<td>92.7</td>
<td>81.3</td>
<td>66.3</td>
<td>36.8</td>
<td>30.6</td>
<td>38.9</td>
</tr>
<tr>
<td>Moneylenders</td>
<td>69.7</td>
<td>49.2</td>
<td>36.1</td>
<td>16.1</td>
<td>17.5</td>
<td>26.8</td>
</tr>
<tr>
<td>Unspecified</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>


The share of non-institutional credit declined from 92.7 per cent in 1951 to 30.6 per cent in 1991. However during the decade after the reforms share of non-institutional sources increased to 38.9 per cent (year 2002), which is not a healthy trend and is a cause of worry. On the other hand share of institutional sources continued to fall during the same period.


- Institutional
- Non institutional


The continued dependence of small and marginal farmers on informal sources of credit such as private moneylenders was attributed to constriction in the rural banking network and services arising out of financial sector reforms (GOI, 2010). Rigid procedures and systems of formal sources preventing easy access by small and
marginal farmers, vied with the easy and more flexible methods of lending adopted by informal sources. The widespread rural network of around 95,000 primary agricultural credit societies (PACS) across 6 lakh villages, could have reached out to tenant farmers, oral lessees, and small and marginal farmers. However, the functioning of PACS was far from satisfactory, given their transformation from being member-controlled thrift and credit cooperatives to state dependent channels of subsidised credit. Where PACS perform well, they do reach out to those who need them the most (GOI, 2010).

In totality, over the last two decades, what has been observed is a reversal of the public policy objectives of extending the reach of agricultural credit, providing affordable and timely credit to rural households (specifically the economically vulnerable households) and overcoming historical problems of imperfect and fragmented rural credit market. The effects of this policy reversal are corroborated by (GOI, 2005). The survey revealed that the share of institutional credit agencies in the outstanding amount of cash dues of the rural households declined by about 7 percentage points between 1991 and 2002 and was 57 per cent in 2002. This is in sharp contrast to the earlier periods wherein there were gradual increases in each decennium. This share increased from 29 per cent in 1971 to 61 per cent in 1981. Though the rate of increase decelerated, still there was a 3 percentage point’s increase to 64 per cent in 1991. On the other hand, the share of institutional agencies in the amount of debt for urban households increased progressively from 60 per cent in 1981 to 72 per cent in 1991 and 75 per cent in 2002 (GOI, 2005).

**Decline in the Share of Long-term Agricultural Credit**

Since the 1990s, the share of short-term agricultural credit in total agricultural credit went up, and that of long-term credit declined. This was disturbing but not surprising given the slowdown in capital formation in agriculture (Rao, 2012). One of the major impediments constraining the adoption of new technological practices, land improvements and building up of irrigation and marketing infrastructure had been the inadequacy of farm investment capital. Farmers seem to borrow more short-term credit in order to meet input needs to maintain continuity in agricultural operations without worrying about long-term capital formation. The share of Gross Capital Formation (GCF) of agriculture and allied sectors in total GCF consistently decreased from early eighties when it was around (18 to 20 per cent) to around (5 to 6 per cent)
during the year 2007-08 (Fig.3.4). Figure (3.9) clearly shows the growth trends of long and short term credit to agriculture since the beginning of economic reforms programme.

Fig 3.9: Direct Institutional Credit for Agriculture and Allied Activities- Short Term and Long Term

![Graph showing growth trends of short and long term credit for agriculture and allied activities from 1990-91 to 2007-08.]

Source: RBI Handbook 2012

In the beginning share of both short and long term credit was more or less equal but latter on short term credit has grown faster than the long term credit and the gap has been widening over the years. Since the second half of the 1990s, indirect credit to agriculture grew faster than direct credit taking the share of indirect credit in total agricultural credit supplied by commercial banks from about 11 per cent in 1995 to 29 per cent by 2011. During the second half of the 2000s, indirect credit even exceeded its prescribed sublimit under the priority sector guidelines by a narrow margin (Rao, 2012). CAGR (Compound Annual Growth Rate) for direct credit was 19.34 per cent lesser than 30.90 per cent for indirect credit between the years 1990-91 and 2007-08. The rising importance of indirect credit can be interpreted as a reflection of the growing credit needs for strengthening the supply chain infrastructure and the consequent widening of the definition of indirect credit. Several of the loans disbursed as “Agricultural Credit” were in excess of Rs. 10 crore and even Rs. 25 crore. Even as
loans of bigger size steadily grew in number, agriculture loans of less than Rs. 25,000 fell by more than half in the same period (Appendix 2).

3.9.4: Distribution of Agricultural Credit and Issues of Exclusion

There were wide variations in the availability of institutional credit per hectare of gross cropped area in different states. Report of the Advisory Committee on Flow of Credit to Agriculture and Related Activities from the Banking System, (2004) observed that the availability was as high as Rs. 9403 in Tamil Nadu, Rs. 7666 in Kerala, Rs. 5352 in Punjab and Rs. 4604 in Andhra Pradesh, while it was as low as Rs. 311 in Assam, Rs. 667 in Rajasthan and Rs. 698 in Madhya Pradesh during 2001-02. The regional distribution of agricultural credit by commercial banks, both in terms of quantum of credit and the number of accounts, was skewed. There was significant concentration in the southern states (Andhra Pradesh, Karnataka, Kerala, Tamil Nadu) followed by the northern and western states. In contrast, the share of the eastern (Bihar, Jharkhand, Odisha and West Bengal) and the north-eastern states was low (RBI, 2007). NSSO (2005) data revealed that 45.9 million farmer households in the country 51.4 per cent, out of a total of 89.3 million households did not access credit, either from institutional or non-institutional sources. Further, despite the vast network of bank branches, only 27 per cent of total farm households were indebted to formal sources (of which one-third also borrowed from informal sources). Farm house holds not accessing credit from formal sources as a proportion to total farm households was especially high at 95.91 per cent in the North Eastern, 81.26 per cent Eastern and 77.59 per cent in the Central Regions. Thus, apart from the fact that exclusion in general was large, it also varied widely across regions, social groups and asset holdings.

A large proportion of population in the lower strata, which had a major share in the land holdings, received much less credit than it required. This observed phenomenon may be attributed, to the “risk aversion” tendency of the bankers towards small and marginal farmers as against the large farmers, who are better placed in offering collaterals (Golait, 2007). Despite the significant strides achieved in terms of spread, network and outreach of rural financial institutions, the quantum of flow of financial resources to agriculture continues to be inadequate. One of the major impediments constraining the adoption of new technological practices, land improvements and building up of irrigation and marketing infrastructure has been the
inadequacy of farm investment capital. Credit can indeed be an important contributor to increased agricultural production, but only if agricultural credit reaches the farmers, especially, the disadvantaged groups, and they are able to absorb it effectively. The share of marginal and small farmers in the total credit has been shrinking. The need to augment the credit flow to the lower strata of the farming community, which has more shares in the total operational land holdings, becomes all the more important.

The SHG-Bank Linkage model is an outstanding example of an innovation leveraging on community-based structures and existing banking institutions. With regard to KCCS, there is a need to upscale its outreach to cover all the eligible farmers by creating greater awareness and giving greater publicity to the scheme. The co-operative credit structure needs revamping to improve the efficiency of the credit delivery system in rural areas. The extent of revival of credit flow to agriculture in the 2000s would have been far less impressive in the absence of a sharp growth in indirect finance to agriculture. Meeting the task of doubling agricultural credit appears to have become much easier for banks as a result of these definitional changes. Further the entire growth of indirect finance to agriculture in the 2000s originated from a major expansion of loans with a credit limit of more than Rs. 10 crore, and particularly, more than Rs. 25 crore. It appears that much of these large-sized advances were made towards financing large agribusiness-oriented enterprises.

Increased and sustained access to credit by small and marginal farmers, including the most disadvantaged among them is desirable not for the benefit of the farmers only but for increased agricultural production and increased contribution to the GDP. The farmer is a risk-taking entrepreneur who faces uncertainties from weather, spurious inputs, pests and diseases, and market shocks among other risks. With spiralling costs of input-intensive cultivation there is an increasing need for credit. Inadequate and untimely credit along with procedural hassles from formal institutions adds to farmer’s burden. Finally an assessment of agriculture credit situation brings out the fact that the credit delivery to the agriculture sector continues to be inadequate. It appears that the banking system is still hesitant on various grounds to provide credit to small and marginal farmers. The situation calls for concerted efforts to augment the flow of credit to agriculture.
3.10: Diversification, Changing Cropping Pattern and Sources of Growth in Indian Agriculture

The greater emphasis on cereal production (especially rice and wheat) in the past to achieve food security is now dampening agricultural growth (Barghouti et al., 2004). Alternative options need to be explored to revitalize agriculture, make it more profitable and improve its growth performance. Agricultural diversification towards high value commodities (HYVCs) is viewed as one of the most promising strategies to reverse the declining growth trend in agriculture (World Bank, 2002; Rosegrant and Hazell, 2000). Agricultural diversification encompasses change in production portfolio from low-value to more remunerative and high-value commodities like fruits, vegetables, milk, meat, eggs and fish that expand farm and non-farm sources of income. It not only involves production processes but also new marketing and agribusiness-based industrial activities that expand the income sources of rural households and stimulate the overall rural economy. Changes in the share of different commodities in the value of agriculture are used as a proxy of agricultural diversification (IFPRI, 2007).

Sustained economic growth, urbanization and globalization are changing the consumption pattern of Indian consumers from food grains to high-value commodities. This is occurring both in urban and rural areas as well as among rich and poor households. Such changes in consumption patterns clearly reveal that food security is no longer restricted to availability of cereals but involves a diversified food basket that includes high value commodities such as fruits, vegetables, milk, meat, eggs, fish and processed commodities (Rao, 2001). Further the global trade of HYVCs is growing rapidly (Table 3.8). India is gradually responding to the increasing demand for HYVCs in the international market. For example, the share of HYVCs in agricultural exports increased from 21 per cent in 1990 to 36 per cent in 2000 (Rao, et al. 2004). At present, the country is a minor exporter; contributing just 0.5 per cent of global exports of fruits, 1.7 per cent of global exports of vegetables and less than 1 per cent of global export of dairy products during 2001-03 (World Bank, 2005). Low volume of Indian export in the global market despite high production of HVCs reveals ample opportunities for India to increase its participation in the global trade.
### Table 3.8: Agricultural Exports from India (Constant 1990 US CPI)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fruits &amp; Vegetables</strong></td>
<td>Million USD</td>
<td>% share of Agri Exports</td>
<td>Million USD</td>
<td>% share of Agri Exports</td>
<td>Million USD</td>
<td>% share of Agri Exports</td>
<td>Million USD</td>
</tr>
<tr>
<td></td>
<td>160</td>
<td>3.9</td>
<td>120</td>
<td>3.4</td>
<td>189</td>
<td>4.1</td>
<td>194</td>
</tr>
<tr>
<td><strong>Processed Fruits &amp; Vegetables</strong></td>
<td>71</td>
<td>1.7</td>
<td>119</td>
<td>3.4</td>
<td>93</td>
<td>2.0</td>
<td>79</td>
</tr>
<tr>
<td><strong>Meat Products</strong></td>
<td>111</td>
<td>2.7</td>
<td>78</td>
<td>2.2</td>
<td>244</td>
<td>5.4</td>
<td>185</td>
</tr>
<tr>
<td><strong>Marine Products</strong></td>
<td>435</td>
<td>10.5</td>
<td>535</td>
<td>15.2</td>
<td>1058</td>
<td>23.2</td>
<td>913</td>
</tr>
<tr>
<td><strong>Agri Exports</strong></td>
<td>4126</td>
<td>30.7</td>
<td>3521</td>
<td>19.4</td>
<td>4557</td>
<td>13.15</td>
<td>4355</td>
</tr>
<tr>
<td><strong>Total Exports</strong></td>
<td>13460</td>
<td>-</td>
<td>18143</td>
<td>-</td>
<td>33821</td>
<td>-</td>
<td>32344</td>
</tr>
<tr>
<td><strong>HVCs as % of Agri Export</strong></td>
<td>18.8</td>
<td>24.2</td>
<td>34.7</td>
<td>31.5</td>
<td>31.7</td>
<td>32.5</td>
<td>29.4</td>
</tr>
</tbody>
</table>

**Source:** Economic Survey (various issues) & IFPRI, 2007

**Note:** HVCs include fruits & vegetables, Processed Fruits & Vegetables, Meat Products and Marine Products
The cropping pattern in India has undergone significant changes over time resulting in a marked shift from the cultivation of food grains to commercial crops which comprise of fruit and vegetables, livestock products, and fisheries (Kannan and Sundaram, 2011). HVCs account for a large share in the total value of agricultural production. The share of high-value commodities like fruits and vegetables, livestock and fishery products in total VOP of agricultural and allied sector has been increasing steadily over the years. In 1980-81, the share of high-value items in total was around 35.2 per cent which increased to 37.6 per cent by the year 1990-91, to 45.8 per cent by 2000-01 and to 48.9 per cent by 2009-10. Hence the share of food grains and other crops in the basket of commodities declined during this period, though their production in absolute terms increased substantially (Chand and Parappurathu, 2011).

Table 3.9: Share of Area under Major Crops in India

<table>
<thead>
<tr>
<th></th>
<th>1980-81</th>
<th>1990-91</th>
<th>2000-01</th>
<th>2008-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>23.26</td>
<td>22.98</td>
<td>24.12</td>
<td>23.34</td>
</tr>
<tr>
<td>Wheat</td>
<td>12.91</td>
<td>13.01</td>
<td>13.88</td>
<td>14.22</td>
</tr>
<tr>
<td>Coarse Cereals</td>
<td>24.20</td>
<td>19.55</td>
<td>16.33</td>
<td>14.07</td>
</tr>
<tr>
<td>Total Cereals</td>
<td>60.37</td>
<td>55.55</td>
<td>54.33</td>
<td>51.64</td>
</tr>
<tr>
<td>Pulses</td>
<td>13.01</td>
<td>13.28</td>
<td>10.98</td>
<td>11.32</td>
</tr>
<tr>
<td>Total Foodgrains</td>
<td>73.38</td>
<td>68.83</td>
<td>65.31</td>
<td>62.96</td>
</tr>
<tr>
<td>Ground nut</td>
<td>3.94</td>
<td>4.47</td>
<td>3.54</td>
<td>3.40</td>
</tr>
<tr>
<td>Rapeseed and mustard</td>
<td>2.38</td>
<td>3.11</td>
<td>2.42</td>
<td>3.23</td>
</tr>
<tr>
<td>Soyabean</td>
<td>0.35</td>
<td>1.38</td>
<td>3.46</td>
<td>4.87</td>
</tr>
<tr>
<td>Total oilseeds</td>
<td>10.20</td>
<td>13.00</td>
<td>12.29</td>
<td>14.13</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>1.55</td>
<td>1.99</td>
<td>2.33</td>
<td>2.27</td>
</tr>
<tr>
<td>tea</td>
<td>0.22</td>
<td>0.23</td>
<td>0.27</td>
<td>0.30</td>
</tr>
<tr>
<td>Coffee</td>
<td>0.11</td>
<td>0.12</td>
<td>0.17</td>
<td>0.20</td>
</tr>
<tr>
<td>Cotton (lint)</td>
<td>4.53</td>
<td>4.01</td>
<td>4.60</td>
<td>4.82</td>
</tr>
<tr>
<td>Raw Jute &amp; Mesta</td>
<td>0.75</td>
<td>0.55</td>
<td>0.55</td>
<td>0.46</td>
</tr>
<tr>
<td>Tobacco</td>
<td>0.26</td>
<td>0.22</td>
<td>0.14</td>
<td>0.20</td>
</tr>
</tbody>
</table>


With lesser scope for further increase in area under cultivation the increased demand for food because of increase in population and urbanisation led to intensification and substitution of food crops with commercial crops. As a result area under food grains in gross sown area (GSA) declined by 10.42 per cent between
1980-81 and 2008-09 mainly due to fall in area under coarse cereals. Area under coarse cereals fell from 24.20 per cent during 1980-81 to 14.07 per cent during 2008-09 (Table 3.9). At the same time wheat gained importance as the area under wheat cultivation increasing from 12.91 per cent in 1980-81 to 14.22 per cent in 2008-09 and area under rice remained more or less constant during the period under study. The area lost by food grains especially coarse cereals was used for the cultivation of oilseeds, fruits, vegetables and non-food crops. Although the shift from coarse cereals to high value crops increased farm output and income to farmers, in dry land regions it exposed cultivators to serious weather-borne risks because of high water requirement of high value crops (Bhalla and Singh, 2009).

Increase in area under total oilseeds was mainly the result of rapeseed and mustered, soyabean and sunflower and not due to all oil seed crops since area under groundnut came down from 3.39 per cent in 1980-81 to 3.40 per cent in 2008-09. Favourable market conditions for refined oil and protein-rich soya food might have been responsible for inducing farmers to allocate larger areas for these crops (Srinivasan, 2005). However, the area under commercial crops like cotton showed a marginal increase from 4.53 per cent to 4.82 per cent between years 1980-81 and 2008-09 while that of sugarcane increased from 1.55 per cent in 1980-81 to 2.27 per cent in 2008-09. Thus the area under commercial crops increased during the said period.

Appendix 5 gives value of output from agriculture at various points of time during last three decades. It is observed that among crop groups, cereals accounted for the largest share of total output followed by fruits and vegetables, oilseeds and fibres. While the contribution of cereals declined from 37.74 per cent in year ending 1980-81 to 29.07 per cent in year ending 2009-10, the share of fruits and vegetables increased considerably from 15.81 per cent to 27.81 per cent during the same period. The changing share was largely determined by commodity price, which rose proportionately higher for fruits and vegetables rather than cereals during the recent decade (Chand et al., 2011). Among the individual crops, rice accounted for major share in the total value of output, but declined from 2000-01 onwards. Similarly, the value of wheat output reported a steady increase until 2000-01 and declined thereafter. Pulses also registered a decline in value of output from 6.53 per cent in year ending 1980-81 to 4.35 per cent in year ending 2009-10. Despite increase in
producer price of pulses, output did not keep pace due to the vagaries of weather and allocation of smaller area for cultivation of pulses by farmers. The value of output of Cotton, however, increased in the current decade since 2000-01. The widespread cultivation of Bt cotton was the major reason for the rise in production of cotton. It was found that productivity and profit from Bt cotton cultivation was substantially higher than the conventional hybrid cotton varieties (Naik et al., 2005). Bt cotton cultivation increased yields in most areas and at the same time reduced pesticide sprays. The combined cost savings from reduced pesticide use and increased yields has thus increased profits for farmers (Guillaume et al., 2008). Condiments, spices and sugar also registered an increase in their shares in total value of output.

Overall, the analysis of the data clearly indicated that there was broad-based agricultural production in the 1980s but the phenomenon of commercialisation of agricultural production seems to have gained momentum since early 1990s. There is a definite shift from food grains to non-food grains such as fruits and vegetables, oilseeds, fibres and condiments and spices whose share in both area and in value of output has been increasing over time (Kannan and Sundaram, 2011). Agricultural performance in India has been highly volatile with less than desired rate of 4 per cent growth achieved during last three five year plans (Ninth Plan to Eleventh Plan). But during the same time Indian agriculture increasingly diversified from traditional crops to high value commodities. The diversifying trends in Indian agriculture were indicative of the change in demand patterns towards high value, protein rich food. This also marked a need to shift the policy approach towards agriculture; from supply push to demand pulls (Gulati & Ganguly, 2010).

The pattern in the sources of growth has implications for the agricultural development policies (Minot, 2003). For example, if a large share of the growth in crop income is associated with area expansion, this may reflect an unsustainable trend, particularly if arable land is limited. Similarly, a pattern in which much of the growth is related to price increases may reflect changes in policy or reduced transportation costs, but it is probably not sustainable in the long run. In either case, the implication is that greater efforts should be made to improve yields and help farmers diversify into higher-value crops (Joshi et al., 2006). (Appendix 6) gives information about share per cent of different commodities in the sources of agricultural growth in India during 1980s and 1990s. The information in above table
is decomposed into area effect, yield effect, price effect, and diversification on growth over various food grains and commercial crops. The crop diversification emerged as a prominent source of growth in agriculture both during 1980s and 1990s. The rise in its share in the growth was an indication of the changing production portfolio in favour of superior and high-value commodities. During the 1980s, the area substitution was in favour of oilseeds, while the trend shifted to wheat and fruits & vegetables in 1990s (Kakarlapudi, 2012). The share of fruits and vegetables in crop diversification went-up to 61 per cent during 1990s from about 56 per cent during 1980s (Appendix 6).

It is interesting to note that the contribution of output prices and crop diversification (particularly of fruits & vegetables) had gone up in agricultural growth during the reform period, whereas during the pre-reform period, it mainly relied on technology and crop diversification (particularly oilseeds and fruits & vegetables). During the reform period, the focus was on agricultural prices, particularly of rice and wheat, whose prices depicted a change of (30 and 27 per cent), respectively. However, a continuous rise in the output prices is not a sustainable source of growth in the long-run. Increasing production and globalization could suppress the output prices and may affect the agricultural growth adversely. Thus, accelerating the pace of crop yields (through technological change) and crop diversification (in favour of high-value commodities) are the options to provide sustainable sources of agricultural growth in future (Kakarlapudi, 2012).

**Summing up:**

Agricultural growth since 1990-91 reflected the impact of economic reforms on agricultural performance. The most important feature of this period was that agricultural growth decelerated sharply at all India level and in all regions. The main reason for the deceleration of growth during the post reform period was a visible deceleration in investment in irrigation and other rural infrastructure. There was a continuous decline in the share of Gross Capital Formation (GCF) of agriculture and allied sectors in total GCF. Moreover, there was a significant decline in the allocation of public outlay on agriculture as a per cent of total public outlay during the post-reform period compared to that in pre-reform period. Although the all-India average consumption of fertilizers increased substantially the average intensity of fertilizer use in India remained much lower than most countries in the world. Further the use of fertilizer is highly skewed with wide inter-regional, inter-state and inter-district
variations. The increasing divergence between the growth trends of the total economy and that of agriculture and allied sectors suggests ‘under performance’ by agriculture. The commercialisation of agricultural production seemed to have gained momentum since early 1990s. There was a definite shift from food grains to non-food grains such as fruits and vegetables, oilseeds, fibres and condiments and spices whose share in both area and in value of output increased over the period. In the backdrop of all these developments net chapter looks into issues and challenges facing Indian agriculture.