CHAPTER – III

Data and Methodology
3.1 Introduction

In the present study, the growth in area, yield and production of four major crops in A.P., viz., rice, maize, groundnut and cotton, integration of domestic and international markets, competitiveness of these crops and implications of WTO on A.P. agriculture were analyzed. To carry out this analysis the following tools and techniques are employed. The database, sources of data and analytical tools employed in analyzing the objectives of the study are as follows:

3.2 Types of Data:

To study the competitiveness of exports of selected crops from A.P, the free on board (FOB) prices, cost insurance freight (CIF) prices and domestic wholesale prices that prevailed in major A.P. markets were collected. Also the analysis is based on the secondary data collected from various sources such as the Center for Monitoring Indian Economy, publications and official web sites of government of Andhra Pradesh (www.aphorticulture.com, www.aponline.com).

In order to assess integration of markets in the state with international markets, monthly wholesale prices were collected for the period from 1986-87 to 2009-10. The markets selected for the study are as follows. For rice, Nizamabad is selected as the local market and Thailand for the international market. For groundnut, Nandyal is selected as local market and Rotterdam as international market. For cotton, Guntur and Liverpool are selected as local and international markets respectively. For maize the markets selected were Warangal for local market and US gulf as international market.

Destination wise exports were collected to study the structural change in exports. The major importing countries considered for analysis of trade in rice were Kuwait, Saudi Arabia, U.K, USA, Yamen and UAE. For cotton, the importing countries selected were China, Bangladesh, Belgium, Italy and Japan. The major importers considered for groundnut were Indonesia, Malaysia, Philippines and U.K.
3.3 Period of Study

The study is based on secondary data covering a period of 14 years from 1996-97 to 2009-10 for the calculation of transitional probability matrix. Whereas compound growth rates of area, yield and production of selected four crops were calculated for Andhra Pradesh as well as for India for two sub periods, namely, pre-WTO period (1976-77 to 1994-95) and post-WTO period (1995-96 to 2012-2013) as well as for the overall period (1976-77 to 2012-13). To assess the integration of markets in the state with international markets, the period from 1986-87 to 2009-10 has been considered.

3.4.1 Sources of Data

The secondary data relating to area, yield and production of selected crops (rice, maize, groundnut and cotton) were collected from publications of Center for Monitoring Indian Economy (CMIE) Pvt. Ltd., Mumbai. Data on destination wise exports in terms of quantity and value were obtained from “Monthly statistics of foreign trade of India”, published by Directorate General Commercial Intelligence and Statistics, Kolkata. International reference prices of the crops under study were collected from various issues of FAO production year book. The maritime freight rates were obtained from FAO trade year book (2010). Information on domestic prices of selected crops and other agricultural statistics were compiled from various issues of Season and Crop report and Statistical abstract of A.P. published by Directorate of Economics and Statistics, Hyderabad. Data on cost of cultivation of selected crops were obtained from Cost of Cultivation scheme, Hyderabad.

3.5 Tools of Analysis

The study demands the following analytical tools to analyze the objectives and to draw valid conclusions.
3.5.1 Growth Rates

The growth in area, production and productivity were computed from the regression function of the form

\[ Y = \alpha \beta^t U_t \]  

where

- \( Y \) = Dependent variable
- \( \alpha \) = Intercept or constant
- \( \beta \) = Regression coefficient
- \( t \) = Time variable
- \( U \) = Error term or Random error term.

By taking logarithm on both sides of the equation (1), we get the following equation as

\[ \ln Y = \ln \alpha + t \ln \beta + \ln(U) \]

The compound growth rate was derived by using the relationship

\[ \text{CGR} = \text{Antilog of } (\beta - 1) \times 100 \]

3.5.2 Instability Index

In order to study the variability in the area, production, productivity and export trade of selected crops, an index of instability was developed as a measure of variability. The coefficient of variation (CV) was calculated using the formula:

\[ CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100 \]
3.5.3 Markov Chain Analysis

The structural change in exports was examined by using the Markov chain model. Central to the Markov model is the transitional probability matrix ‘P’. The elements \( P_{ij} \) (where \( i \neq j \)) of this matrix indicate the probability that exports will switch from country ‘i’ to country ‘j’ over time. The diagonal element \( P_{ij} \) (\( i=j \)) of the transitional probability matrix measures the probability of a country retaining its market share. In other words, an examination of the diagonal elements of the transitional probability matrix indicates the loyalty of an importing country to a particular country’s exports.

In the context of current application, structural change was treated as a random process in which five importing countries for Basmati rice and groundnut and four importing countries for cotton were considered. The average export of the selected crops from India amongst importing countries in any period depends only on the export in the previous period and this dependence is same among all the periods. Mathematically it can be expressed as

\[
E_{jt} = \sum_{i=1}^{n} [ E_{it-1} ] P_{ij} + U_{jt} \quad \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots (5)
\]

where

\( E_{jt} = \) exports from India to the \( j^{th} \) country in the year \( t \)

\( E_{it-1} = \) exports of \( i^{th} \) country during the year \( t-1 \)

\( P_{ij} = \) the probability that exports will shift from \( i^{th} \) country to \( j^{th} \) country

\( U_{jt} = \) the random error term which is statistically independent of \( E_{it-1} \)

\( n = \) the number of importing countries
The transitional probabilities $P_{ij}$, which can be arranged in a matrix, have the following properties:

$$0 \leq P_{ij} \leq 1\ 	ext{and}$$

$$\sum_{i=1}^{n} P_{ij} = 1, \text{for all } i$$

Thus, the expected export share of each country during period ‘t’ is obtained by multiplying the exports to these countries in the previous period (t-1) with the transitional probability. The probability matrix was estimated for the period 1996-97 to 2009-10.

The transitional probability matrix is estimated in the linear programming (LP) framework by a method referred to as minimization of Mean Absolute Deviation (MAD).

Minimize $OP^* = I\ U$

Subject to

$$XP^* + V = Y$$

$$GP^* = 1$$

$$P^* \geq 0$$

where

$P^*$ is a vector of probabilities $P_{ij}$

$O$ is the vector of zeros

$I$ is an appropriately dimensional vector of areas

$U$ is the vector of absolute errors

$Y$ is the proportion of exports to each country
X is a block diagonal matrix of lagged values of Y

Y is the vector of errors

G is a grouping matrix to add the row elements of P arranged in P* to unity.

3.5.4 Co-integration Technique

The co-integration approach to market integration is intuitively appealing and straightforward in application. Integrated markets are those where prices are determined interdependently. Generally this has been assumed to mean that the price changes in one market will be fully transmitted to the other markets. Markets that are not integrated may convey inaccurate price that might distort marketing decisions and contribute to inefficient product movements.

According to this approach, two series are said to be co-integrated when there exists a long term relationship between them. In other words, two series cannot drift from one another in the long run. That is, there exists an equilibrating mechanism to bring the two series together. Applying this concept to any two given markets, co-integration between their price series implies long run dependence between them. Since, the very essence of market integration is the price dependence across markets, it follows that co-integration between prices in two given markets implies integration of the markets.

To examine the price relation between two markets, the following basic relationship that is commonly used to test for the existence of market integration has been considered:

\[ P_{it} = \alpha_0 + \alpha_1 P_{jt} + \varepsilon_t \]  \hspace{1cm} (7)

where \( P_{it} \) and \( P_{jt} \) are price series of a specific commodity in two markets \( i \) and \( j \), \( \varepsilon_t \) is the residual term assumed to be distributed identically and independently.

The test of market integration is straightforward if \( P_i \) and \( P_j \) are stationary variables. Often, however, economic variables are non stationary in which case the
conventional tests are biased towards rejecting the null hypothesis. Thus, before proceeding for further analysis, it is important to check for the stationarity of the variables.

Stationary series is defined as one whose parameters that describe the series (namely the mean, variance and autocorrelation) is independent of time; or rather exhibit constant mean and variance and have autocorrelation that are invariant through time. Once the non stationarity status of the variables is determined, the next step is to test for the presence of co-integrating (long run equilibrium) relationship between the variables.

The Augmented Dicky Fuller (ADF) (1979) test is used to determine the stationarity of a variable. In this test the ADF critical significance values are not quite appropriate. Engle and Granger have given the critical significance values. Therefore the ADF test in this context is known as augmented Engle-Granger test. However several software packages now present these critical values along with outputs. For this problem the following equation is considered.

\[ \Delta P_t = \beta_0 + \beta_1 P_{t-1} + \alpha \sum_{k=1}^{N} \Delta P_{t-k} + \eta_t \]  

\[ \Delta P_t = P_t - P_{t-1} \]

The above equation is to be estimated, obtain the residuals and then use the ADF test. The test statistic is simply the statistic. However, under the null hypothesis it is not distributed as Student-t, but this ratio can be compared with critical values tabulated by Engle-Granger. In estimating Equation (8), the null hypothesis is Ho: \( P_t \) is I (1), which is rejected [in favour of I(0)] if \( \beta_1 \) is found to be negative and statistically significant. The above test can also be carried out for the first difference of the variables. That is, we estimate the following regression equation:

\[ \Delta^2 P_t = \theta_0 + \theta_1 \Delta P_{t-1} + \Phi_k \sum_{k=1}^{N} \Delta^2 P_{t-k} + \mu_t \]  

\[ K=1 \]
where the null hypothesis is $H_0$: $P_t$ is I(2), which is rejected [in favour of I(1)] if $\theta_1$ is found to be negative and statistically significant. In general, a series $P_t$ is said to be integrated of order ‘d’, if the series achieves stationary after differencing ‘d’ times, and it is denoted as $P_t \sim I(d)$. Consequently, if we get $P_t$ is stationarity series after differencing once, it is denoted as $P_t \sim I(1)$.

Having established that the variables are non-stationary in level, we may then test for co-integration. Only variables that are of the same order of integration may constitute a potential co-integrating relationship.

For this study, the important domestic markets considered in the state are Nizamabad for rice, Nandyal for groundnut, Warangal for maize and Guntur for cotton. Based on the past studies of Reddy (1997) and Ramesh Chand (2002), the following international markets have been considered. They are Thailand for rice, US gulf for maize, Liverpool for cotton and Rotterdam for groundnut. In order to test the secular relationship between domestic and international markets of selected crops the above mentioned procedure was followed.

3.5.5. Measures of Trade competitiveness

Three kinds of measures, Viz., Nominal Protection Coefficients (NPC), Effective Protection Coefficients (EPC) and Domestic Resource Cost (DRC) have been widely used to reveal trade competitiveness. The first two measures are used to find the level of protection of and level of government intervention in different commodities. But Domestic Resource Cost (DRC) is generally used to measure the efficiency and comparative advantage in production vis-à-vis export or import of various commodities. Trade competitiveness has been estimated for selected commodities of the state for the period 1986-87 to 2009-10.

(a) Nominal Protection Coefficient (NPC)

The Nominal Protection Coefficient (NPC) of a commodity is defined as the ratio of the domestic price to its border price (Tweeten, 1992). Pursell and Gupta (1998) defined NPC of a commodity as the ratio of that commodity’s domestic price to its international reference price and referred to it as an estimate of the extent to
which its price has been affected by government interventions in the country’s international trade. NPC determines the degree of export/import competitiveness of commodities by measuring the divergence of domestic price from the international or border price.

**(b) Effective protection coefficient (EPC)**

The EPC is an indicator for measuring trade price and exchange rate related distortions through tradable input and output prices of the value added of a particular product. The EPC captures transfers due to distortions in input as well as output prices on the product’s value addition that is output price (gross value) less specified (usually variable) traded input costs. The EPC for commodity is defined as

\[
EPC_i = \frac{VA_i^d}{VA_i^b}
\]

where \(VA_i^d\) is the value added output I at domestic prices and \(VA_i^b\) is the value-added output I at border prices. EPC value greater than unity indicates that the value added at domestic prices is higher than value added at border prices, and hence the output is effectively protected through the combination of domestic output and input price policy. In contrast, a positive EPC with less than unity implies overall producer taxation; domestic value added is effectively taxed. When EPC is one, the output is neither taxed nor subsidized, and value added at domestic price is equal to the value added at border prices.

**(c) Domestic Resource Coefficient (DRC)**

The DRC ratio also measures the efficiency of domestic production in terms of its international cost competitiveness. The DRC coefficient compares the opportunity costs of using domestic primary resources - land, labour and capital and of traded inputs in domestic production to the value added by that production at border prices:

\[
DRC = \frac{a_{ij} v_j}{(P_i^b - a_{ij} P_i^b)}
\]

where \(a_{ij}\) (j = K + 1 to n) is the technical coefficient (input use per unit of output) for domestic resource j (non-trade intermediary input) in the production of output i and \(v_j\) is the shadow price of such an input. When DRC ratio is lower than one, domestic
production is efficient and internationally competitive because the opportunity cost of spent domestic resources is smaller than the net foreign exchange gained in export or saved by substituting for imports. A DRC ratio of less than one is thus taken as an indicator of long run comparative advantage. The opposite is true when DRC ratio is larger than one (Yao, 1977).

The various measures of trade competitiveness, viz., NPC, EPC, DRC etc, have been computed using the Policy Analysis Matrix (PAM). The nature of Policy Analysis Matrix and the formulae used in the calculation of NPC, EPC, DRC etc are presented below:

**Policy Analysis Matrix (PAM)**

The PAM is essentially a double accounting technique that summarizes budgetary information for farm and post-farm activities. While simple to use, it is theoretically rigorous and derived from social cost-benefit analysis and international trade theory in economics. The basic steps in using the PAM method are - identifying the commodity system, assembling representative budgets for each activity in the system, calculating social values, aggregating the budgetary data into a matrix, analyzing the matrix and simulating policy changes.

The method rests upon a familiar identity: \( \text{Profit} = \text{Revenue} - \text{Costs} \).

For reasons that will soon be apparent, costs are divided into those inputs that are traded on international markets (fertilizers, pesticides, hybrid seeds) and those domestic factors (labour, land, and capital), which are not traded internationally. This gives us the following profit identity:

\[ \text{Profit} = \text{Revenue} - \text{Cost of tradable inputs} - \text{Costs of domestic factors} \]

PAM is measured in two types of prices: private and social, which are defined clearly in the context of working with a PAM. Private values are prices at which we observe goods and services actually being exchanged and those which we have used in our budgets-the price of crop, the cost of seed, fertilizers, farm yard manures, pesticides and the going wage rate. These are also called market or financial prices.
Social values are the prices, which would prevail in the absence of any policy distortions (such as taxes or subsidies) or market failures (such as monopolies). They reflect the value to society as a whole rather than to private individuals, and are the values used in economic analysis when the objective is to maximize national income. These are sometimes called shadow prices, efficiency values, or opportunity costs.

The social costs have been calculated using Value Marginal Product approach, which uses factor share ($S_i$) of various inputs ($X_i$) together with the mean values of inputs and outputs ($Y$) and prices ($P_i$). The computation of the social cost of input is as follows:

$$P_{Xi} = [(S_i/X_i)*Y] P_Y$$

Once all private values have been matched with their social equivalents, we arrive at two identities:

Private profit ($D$) = Private revenue ($A$) - Private cost of tradable inputs ($B$) - Private cost of domestic factors ($C$)

Social profit ($H$) = Social revenue ($E$) - Social cost of tradable inputs ($F$) - Social cost of domestic factors ($G$)

The NPCI, DRC, EPC and SRP are calculated by the following equations:

- The Nominal Protection Coefficient on tradable Inputs (NPCI) = $B/F$,
- Domestic Resource Ratio (DRC) = $A/E$  
- Effective Protection Coefficient (EPC) = $(A - B)$/(E – F), and
- Subsidy Ratio to Producers (SRP) = $(D - H)/E$.

An important thing to keep in mind is that for a given commodity system, the costs and profits represent an aggregate for all activities from farm to wholesale. For revenues, A is the whole sale price, and E is the world price of the comparable product in the comparable location. Private profit (D) is the aggregate measure of net returns for all activities in the system. In contrast, social profit (H) represents the
foreign exchange saved by reducing imports or earned by expanding exports of a unit of this commodity.

3.5.6. Partial Equilibrium Methods

The welfare gains or losses both to producers and consumers were estimated using the partial equilibrium method which is followed by Lutz and Scandizzo (1980).

Price distortions on domestic as well as international market and domestic agricultural policies will have an impact on incomes of producers, consumers and government revenues. These distortions are created on account of protectionist policies followed by the governments. With liberalization, these policy distortions will change. In the current study the extent of price discrepancies were computed. Partial equilibrium methods can readily be used to evaluate the impact of the price changes on demand, supply and welfare. The basic analytical structures of the partial equilibrium models are summarized as follows. The following formulae are applied for different prices affecting producers and consumers:

\[ a) \quad \text{Net Social Loss in Production (NSL}_p\text{)} = \frac{1}{2} (Q_w - Q) (P_w - P_p) \]

\[ b) \quad \text{Net Social Loss in consumption (NSL}_c\text{)} = \frac{1}{2} (C_w - C)(P_w - P_c) \]

\[ c) \quad \text{Net Social loss (NSL)} = \text{NSL}_p + \text{NSL}_c \]

\[ d) \quad \text{Welfare gain to producers (WG}_p\text{)} = Q(P_p - P_w) - \text{NSL}_p \]

\[ e) \quad \text{Welfare loss to consumers (WL}_c\text{)} = Q(P_w - P_c) - \text{NSL}_c \]

where

\[ Q_w = \text{Production at world prices} \]

\[ Q = \text{Production at domestic prices} \]

\[ P_w = \text{Border prices} \]

\[ P_p = \text{Price faced by domestic producers} \]

\[ P_c = \text{Price faced by domestic consumer} \]

\[ C_w = \text{Consumption at world prices} \]

\[ C = \text{Consumption at domestic prices} \]
The basic parameters needed in this evaluation are the elasticities of supply and demand. The evidence on agricultural supply elasticity is unfortunately weak and diverse. In the present study, the supply and demand elasticities were assumed based on the past studies of Reddy (1997) and Raghavendra (2004). For calculation of production values, the wholesale prices of commodities were used, whereas, for consumption values, the retail prices of commodities were used.