CHAPTER I

INTRODUCTION
CHAPTER-I
INTRODUCTION

Agriculture continues to dominate in India’s economic development, accounting one third of its Gross Domestic Product (GDP) and one-fifth of foreign exchange. This sector provides more than 70 percent of the total labour force in the country. Besides, its forward linkages and backward linkages with other sectors of the economy are the other established facts. Nearly 80 percent of India’s population lives in rural areas and is directly or indirectly dependent on agriculture. India’s water resource too, reveals the fact that if the available water potential when fully exploited would bring half of the cultivated area under irrigation. The input system of the country presents the fact that India is a country of ever expanding resource structure capable of meeting out the demand for agriculture particularly in the context of increasing crop yield. According to Johnston B.F. and Meller\(^1\) “some aspects of agriculture’s role appear to have a high degree of generality because of special features that characterise the agricultural sector during the course of economic development”.

Many growth theories have advanced the role of agriculture in the economic development of a backward economy like India. Lewi’s\(^2\) ‘Two Sector Model’ followed by Rani’s and Fei\(^3\) for development stressed the existence of enormous supply in a potential farm and therefore it is very


necessary to explore the possibility of utilization of the surplus for economic development.

Under these background, many developing countries where the population pressure is heavy, increase in agricultural production constitutes a pre-requisite for economic development and holds the key for rapid material progress. Rising agricultural productivity along with the diversified urban industrial development have contributed much for each other.\(^4\) But in some countries industrial development become possible without agricultural development. This is more appropriate in the case of a closed economy, where one of the most important pre-conditions of industrial expansion is the achievement of a rate of increase in agricultural productivity which exceeds the concurrent rate of increase in the demand for food.\(^5\) Thus, agricultural development is more important for industrial development in developing countries like India. According to Caole and Hoover, "very substantial progress in the most backward part of the economics (agriculture) is a pre-requisite to economic development.... Economy as a whole and that is one sector limits the growth of the other, it is more likely to be a case of agricultural growth limiting the non-agricultural than vice versa."\(^6\) Higgins too warns about the 'dangers of industrialisation without an agricultural revolution' and 'neglect of the agricultural sector'.\(^7\)

\(^7\) Benjamin Higgins op.cit.
Thus, agricultural in a broader prospective contributed much to the economic development of a country, especially through the strategy of increased agricultural production and productivity. Further, it also solves the problem of growing demand for food, earns foreign exchange through expanded system of exports, provides labour force for manufacturing and other expanding sectors of the economy, provides capital for expansion of secondary industry and also for overhead investment and stimulates purchasing power of the rural people.

No doubt, agricultural production in India has marked a significant break through since early sixtees. Both production and yield have increased significantly, more specifically after the introduction of The New Agricultural Technology. Adoption of new HYV seeds, use of modern inputs like fertilizer, tractors, pesticide and insecticide, pumpsets, and other machineries have comprehensively changed the Indian agriculture to the extent of competing with the world countries to some level. Another, important feature witnessed in the Indian agricultural scenario is the emphasis it places on the organisational and institutional arrangements for the production and distribution of the entire package of inputs as well as the extension services which have brought a spectacular achievement in agricultural production and yield levels to attain self sufficiency in food grain and improved the efficiency of farm resources in Indian agriculture. However, these changes are not uniform across crop farms and regions in the country. On the other hand, it has increased the disparities among regions in
the country. The resource bias of new agricultural strategy has lead to uneven
distribution of benefits across different size group of farms between regions
in the country. C.H.Hanumantha Rao has argued that inter-regional
disparities in growth of agriculture in the post 1977-78 period were not as
sharp as in the first decade of green revolution.8

However, there seems to be a general perception that the new
agricultural technology, even in the revived scenario have benefited much to
the large farmers than the small and marginal farmers. This was not
unexpected that the new technology called for substantial investments which
were generally beyond the means of a majority of the country’s small and
marginal farmers. Only rich farmers who were in a position to offer the new
strategy which is a package programme involving the use of high-yielding
varieties of seed in combination with other inputs like irrigation, fertilizers,
pesticides etc., have shifted the advantages of productivity per acre infavour
of big farmers, during the early phase of Green Revolution.9 Moreover, in a
study on the Effects of Green Revolution on the Small and Marginal Farmers
conducted for Punjab, G.S.Bhalla and G.K.Chadha10 concluded that the
advent of the green revolution in Punjab has brought overall prosperity to its
peasantry. However, the same study admitted that about one-third of the
marginal farmers continue to live below the poverty line and about 24 percent

Delhi,2001 P.819.
9 G.R.Saini, : “Green Revolution and the Distribution of Farm Incomes”, Economic and Political Weekly,
March 27, 1976.
p.820)
of the small farmers also lived below the poverty line.\textsuperscript{11} Utsa Patnaik in a study indicated that adoption of new techniques was strongly concentrated in a minority of labour-hiring holdings; while the majority of self-employed households and those hiring out labour or with substantial dependence on leased in land failed to reach even poverty level incomes.\textsuperscript{12}

**GROWTH TRENDS IN INDIAN AGRICULTURE**

In a broader perspective, the growth of Indian agriculture is witnessed with two major components viz., Agricultural Production and Productivity. The two constituents of agricultural production are food grains and non-food grains. Food grain production form approximately two-thirds of total agricultural production. Rice and wheat are the important food grains which have been received attention by all states; while sugarcane and cotton are the most important non-food items grown on a larger scale in some states. The indices of growth trend in Indian agriculture with respect to area under crops, yield, index number of area, yield and production, state wise distribution of yield rate and production of select crops are presented table I to VI.

The growth in production of agricultural crops mainly depends on two factors, viz. 1) increase in the area under cultivation 2) increase in the yield per hectares.

The area under cultivation can be increased either through adoption of such practices as double-cropping and multiple-cropping or by the reclamation of uncultivated or waste lands. Some concerted efforts have been

\textsuperscript{11} Ibid.

made during the five year plan to increase the area of cultivable land. The index number of the area under cultivation of food grain cultivation went up from 98.7 in 1950-51 to 105.4 in 1995-96. The increase in area under crops was made possible by the fact that large land reclamation and soil conservation programmes were initiated during the plans. The index number of the area under cultivation again went up to 109.6 in 1998-99 from 106.0 in 1996-97.

After 1998-99, the index number of area under cultivation has declined to 103.4 in 2001-02. The total area under the cultivation of food grains was 121.0 million hectares in 1995-96 and increased to 125.2 million hectares in 1998-99. During the periods 1999-2000 and 2000-01, the area under the cultivation of foodgrains declined to 123.0 million hectares and 121.0 million hectares respectively. In India paddy is cultivated nearly 40 percent of the total area. Area under paddy cultivation has went up from 42.8 million hectares in 1995-96 to 45.2 million hectares in 1999-2000. During 2000-01 and 2001-02, the area under paddy has declined to 44.7 million hectares and 44.6 million hectare respectively. Of the total area under paddy cultivation 70 percent of the area has been used for high yielding varieties.

The area under cultivation of agricultural crop in India from 1995-96 to 2001-02 is presented in table-I
From table, it is observed that the area under cultivation of food grain crops viz., Paddy, Wheat, Jowar, Maize, Bajra and others have increased from 98.7 million hectares to 100.2 million hectares in the year 2001-02. Among the food grain crops cultivated, paddy tops the list, accounting 44.6 million hectare followed by wheat, registered with 25.9 million hectares for the year 2001-02. In other words, the total area under cultivation of food grain had been recorded with a marginal rise up to 2000-01, showed a decline of 0.5 million hectares in the year 2001-02. The area under cultivation of paddy tends to fall over years, while increasing trend is observed in the case of wheat.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I Foodgrains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A Cereals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Paddy</td>
<td>42.8</td>
<td>43.4</td>
<td>43.4</td>
<td>44.8</td>
<td>45.2</td>
<td>44.7</td>
<td>44.6</td>
</tr>
<tr>
<td>2. Wheat</td>
<td>25.0</td>
<td>25.9</td>
<td>26.7</td>
<td>27.5</td>
<td>27.5</td>
<td>25.7</td>
<td>25.9</td>
</tr>
<tr>
<td>3. Jowar</td>
<td>11.3</td>
<td>11.4</td>
<td>10.8</td>
<td>9.8</td>
<td>10.2</td>
<td>9.9</td>
<td>9.9</td>
</tr>
<tr>
<td>4. Maize</td>
<td>6.0</td>
<td>6.3</td>
<td>6.3</td>
<td>6.2</td>
<td>6.4</td>
<td>6.6</td>
<td>6.6</td>
</tr>
<tr>
<td>5. Bajra</td>
<td>9.3</td>
<td>10.0</td>
<td>9.7</td>
<td>9.3</td>
<td>8.9</td>
<td>9.8</td>
<td>9.5</td>
</tr>
<tr>
<td>6. Other Cereals</td>
<td>4.3</td>
<td>4.3</td>
<td>4.1</td>
<td>4.1</td>
<td>3.8</td>
<td>3.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>98.7</td>
<td>101.1</td>
<td>101.0</td>
<td>101.7</td>
<td>102.0</td>
<td>100.7</td>
<td>100.2</td>
</tr>
<tr>
<td>B Pulses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FOODGRAINS (A+B)</td>
<td>121.0</td>
<td>123.6</td>
<td>123.8</td>
<td>125.2</td>
<td>123.1</td>
<td>121.0</td>
<td>121.9</td>
</tr>
<tr>
<td>II Non-foodgrains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Groundnut</td>
<td>7.5</td>
<td>7.6</td>
<td>7.1</td>
<td>7.4</td>
<td>6.9</td>
<td>6.6</td>
<td>6.4</td>
</tr>
<tr>
<td>2. Sugarcane</td>
<td>4.1</td>
<td>4.2</td>
<td>3.9</td>
<td>4.1</td>
<td>4.2</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>3. Cotton</td>
<td>9.0</td>
<td>9.1</td>
<td>8.9</td>
<td>9.3</td>
<td>8.7</td>
<td>8.5</td>
<td>9.1</td>
</tr>
</tbody>
</table>

* - Provisional
Among the categories of non-food crops cotton was the single most crop followed by groundnut. The area under cotton was recorded with a marginal rise from 1995-96 to 2001-02; while increasing trend is observed for the area under groundnut cultivation. Sugarcane is yet another non-food crop which showed a continuous increase from 1995-96 to 2001-02, indicating the shift in the cropping pattern towards sugarcane cultivation.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rice</td>
<td>1797</td>
<td>1882</td>
<td>1900</td>
<td>1921</td>
<td>1986</td>
<td>1961</td>
<td>2086</td>
</tr>
<tr>
<td>2</td>
<td>Wheat</td>
<td>2483</td>
<td>2679</td>
<td>2485</td>
<td>2590</td>
<td>2778</td>
<td>2708</td>
<td>2770</td>
</tr>
<tr>
<td>3</td>
<td>Jowar</td>
<td>823</td>
<td>956</td>
<td>697</td>
<td>859</td>
<td>847</td>
<td>764</td>
<td>785</td>
</tr>
<tr>
<td>4</td>
<td>Maize</td>
<td>1595</td>
<td>1720</td>
<td>1711</td>
<td>1797</td>
<td>1792</td>
<td>1822</td>
<td>2018</td>
</tr>
<tr>
<td>5</td>
<td>Bajra</td>
<td>577</td>
<td>788</td>
<td>791</td>
<td>748</td>
<td>650</td>
<td>688</td>
<td>-875</td>
</tr>
<tr>
<td>6</td>
<td>Potato</td>
<td>17000</td>
<td>19000</td>
<td>15000</td>
<td>18000</td>
<td>18000</td>
<td>18000</td>
<td>18000</td>
</tr>
<tr>
<td>7</td>
<td>Groundnut</td>
<td>1007</td>
<td>1138</td>
<td>1040</td>
<td>1214</td>
<td>766</td>
<td>977</td>
<td>1065</td>
</tr>
<tr>
<td>8</td>
<td>Cotton (Lint)</td>
<td>242</td>
<td>265</td>
<td>208</td>
<td>224</td>
<td>225</td>
<td>190</td>
<td>189</td>
</tr>
<tr>
<td>9</td>
<td>Sugarcane (cane)</td>
<td>68000</td>
<td>66000</td>
<td>71000</td>
<td>71000</td>
<td>71000</td>
<td>70000</td>
<td>67000</td>
</tr>
<tr>
<td>10</td>
<td>Tea</td>
<td>1815</td>
<td>1875</td>
<td>1865</td>
<td>1803</td>
<td>1702</td>
<td>1673</td>
<td>1663</td>
</tr>
<tr>
<td>11</td>
<td>Coffee</td>
<td>922</td>
<td>818</td>
<td>799</td>
<td>877</td>
<td>947</td>
<td>959</td>
<td>937</td>
</tr>
<tr>
<td>12</td>
<td>Rubber</td>
<td>1422</td>
<td>1503</td>
<td>1549</td>
<td>1563</td>
<td>1576</td>
<td>1576</td>
<td>1576</td>
</tr>
</tbody>
</table>

NA - Not Available, *-Provisional.

It is clear from table II that the yield rate of rice production in the year 1995-96 was 1797 kgs per hectare; it was 2086 kgs per hectare in the year 2001-02. The yield rate for wheat was 2483 kgs/hectare in the year 1995-96, it went up to 2770 kg/hectare during 2001-02. Among the non-food crops the yield rate of sugarcane was recorded with 68000 kg/hectare in the year 1995-96, and declined to 67000 kg/hectare in the year 2001-02.
From table III, it is observed that the index of area, under production of both food and non-food crops showed a mixed trend. In other words, the area under food crop was recorded to be 95.3 percent in the year 1995-96 and showed a marginal of 0.7 in the year 2001-02. Similar trend is observed in the case of non-food crop as well. However, taking into account all crops the index of area under crop production showed a decline of 103.8 (1995-96) to 103.4 (2001-02) while, increasing trend is observed for production and yield.
### TABLE-IV

**YIELD RATE OF SELECT CROPS: BY MAJOR STATES**

(Kgs. per hectare)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1997-98(2)</td>
<td>1998-99(3)</td>
<td>1999-00(4)</td>
<td>2000-01(5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1997-98(6)</td>
<td>1998-99(7)</td>
<td>1999-00(8)</td>
<td>2000-01(9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1997-98(10)</td>
<td>1998-99(11)</td>
<td>1999-00(12)</td>
<td>2000-01(13)</td>
</tr>
<tr>
<td>1.</td>
<td>Andhra Pradesh</td>
<td>2431</td>
<td>2752</td>
<td>2650</td>
<td>2936</td>
</tr>
<tr>
<td>2.</td>
<td>Assam</td>
<td>1339</td>
<td>1345</td>
<td>1459</td>
<td>1495</td>
</tr>
<tr>
<td>3.</td>
<td>Bihar</td>
<td>1490</td>
<td>1454</td>
<td>1671</td>
<td>1475</td>
</tr>
<tr>
<td>4.</td>
<td>Gujral</td>
<td>1550</td>
<td>1633</td>
<td>1482</td>
<td>810</td>
</tr>
<tr>
<td>5.</td>
<td>Haryana</td>
<td>2797</td>
<td>2239</td>
<td>2385</td>
<td>2559</td>
</tr>
<tr>
<td>6.</td>
<td>Karnataka</td>
<td>2374</td>
<td>2563</td>
<td>2512</td>
<td>2520</td>
</tr>
<tr>
<td>7.</td>
<td>Kerala</td>
<td>1975</td>
<td>2061</td>
<td>2204</td>
<td>2162</td>
</tr>
<tr>
<td>8.</td>
<td>Madhya Pradesh</td>
<td>731</td>
<td>848</td>
<td>981</td>
<td>574</td>
</tr>
<tr>
<td>9.</td>
<td>Maharashtra</td>
<td>1621</td>
<td>1664</td>
<td>1683</td>
<td>1277</td>
</tr>
<tr>
<td>10.</td>
<td>Orissa</td>
<td>1380</td>
<td>1212</td>
<td>1127</td>
<td>1041</td>
</tr>
<tr>
<td>11.</td>
<td>Punjab</td>
<td>3465</td>
<td>3153</td>
<td>3347</td>
<td>3506</td>
</tr>
<tr>
<td>12.</td>
<td>Rajasthan</td>
<td>1164</td>
<td>1222</td>
<td>1262</td>
<td>936</td>
</tr>
<tr>
<td>13.</td>
<td>Tamil Nadu</td>
<td>3050</td>
<td>3579</td>
<td>3481</td>
<td>3416</td>
</tr>
<tr>
<td>15.</td>
<td>West Bengal</td>
<td>2243</td>
<td>2256</td>
<td>2227</td>
<td>2287</td>
</tr>
</tbody>
</table>

**Sl. No.**
- NA = Not Available

**Source:** India’s Agricultural Sector’s: CMIE, Mumbai – 2002.
The state wise distribution on the yield of paddy, sugarcane, cotton and groundnut indicated the fact that per hectare yield of paddy (2001-02) was the highest in Punjab followed by Tamil Nadu, Karnataka occupied a predominant position in the case of sugarcane followed by Tamil Nadu. From the point of view of cotton Punjab tops the list; for groundnut Tamil Nadu retains its position of the topper.

### TABLE-V
PRODUCTION OF SELECT CROPS: ALL INDIA
(Million tonnes)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Food grains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>Cereals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Rice</td>
<td>77.0</td>
<td>81.7</td>
<td>82.5</td>
<td>86.1</td>
<td>89.7</td>
<td>87.7</td>
<td>83.1</td>
</tr>
<tr>
<td>2</td>
<td>Wheat</td>
<td>62.1</td>
<td>69.4</td>
<td>66.3</td>
<td>71.3</td>
<td>76.4</td>
<td>69.7</td>
<td>71.8</td>
</tr>
<tr>
<td>3</td>
<td>Jowar</td>
<td>9.3</td>
<td>10.9</td>
<td>7.5</td>
<td>8.4</td>
<td>8.7</td>
<td>7.5</td>
<td>7.8</td>
</tr>
<tr>
<td>4</td>
<td>Maize</td>
<td>9.5</td>
<td>10.8</td>
<td>10.8</td>
<td>11.1</td>
<td>11.5</td>
<td>12.0</td>
<td>13.3</td>
</tr>
<tr>
<td>5</td>
<td>Bajra</td>
<td>5.4</td>
<td>7.9</td>
<td>7.6</td>
<td>7.0</td>
<td>5.8</td>
<td>6.8</td>
<td>8.4</td>
</tr>
<tr>
<td>6</td>
<td>Other Cereals</td>
<td>4.8</td>
<td>4.7</td>
<td>4.6</td>
<td>4.8</td>
<td>4.3</td>
<td>4.8</td>
<td>14.4</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>168.1</strong></td>
<td><strong>185.2</strong></td>
<td><strong>179.3</strong></td>
<td><strong>188.7</strong></td>
<td><strong>196.4</strong></td>
<td><strong>188.5</strong></td>
<td><strong>198.8</strong></td>
</tr>
<tr>
<td>B</td>
<td>Pulses</td>
<td>12.3</td>
<td>14.2</td>
<td>13.0</td>
<td>14.9</td>
<td>13.4</td>
<td>11.0</td>
<td>13.2</td>
</tr>
<tr>
<td></td>
<td><strong>Food grains (A+B)</strong></td>
<td><strong>180.4</strong></td>
<td><strong>199.4</strong></td>
<td><strong>192.3</strong></td>
<td><strong>203.6</strong></td>
<td><strong>209.8</strong></td>
<td><strong>199.5</strong></td>
<td><strong>212.0</strong></td>
</tr>
<tr>
<td>II</td>
<td>Non-food grains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Groundnut</td>
<td>7.6</td>
<td>8.6</td>
<td>7.4</td>
<td>9.0</td>
<td>5.3</td>
<td>6.4</td>
<td>6.9</td>
</tr>
<tr>
<td>2</td>
<td>Sugarcane (cane)</td>
<td>281.1</td>
<td>277.6</td>
<td>279.5</td>
<td>288.7</td>
<td>299.3</td>
<td>296.0</td>
<td>300.1</td>
</tr>
<tr>
<td>3</td>
<td>Cotton **</td>
<td>12.9</td>
<td>14.2</td>
<td>10.9</td>
<td>12.3</td>
<td>11.5</td>
<td>9.5</td>
<td>10.1</td>
</tr>
<tr>
<td>4</td>
<td>Tea</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

** - Bales of 170 kgs. lint each  NA - Not Available

## TABLE-VI
PRODUCTION OF FOOD GRAINS: SELECT STATES
('000' tonnes)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Andhra Pradesh</td>
<td>11666.6</td>
<td>13675.2</td>
<td>10822.3</td>
<td>14904.9</td>
<td>13423.9</td>
<td>16027.8</td>
</tr>
<tr>
<td>2</td>
<td>Assam</td>
<td>3561.2</td>
<td>3532.1</td>
<td>3577.6</td>
<td>3434.0</td>
<td>4042.6</td>
<td>4166.5</td>
</tr>
<tr>
<td>3</td>
<td>Bihar</td>
<td>12953.4</td>
<td>14417.6</td>
<td>14093.2</td>
<td>13625.9</td>
<td>14561.1</td>
<td>12055.1</td>
</tr>
<tr>
<td>4</td>
<td>Gujarat</td>
<td>4103.3</td>
<td>5208.6</td>
<td>5709.7</td>
<td>5566.7</td>
<td>4051.7</td>
<td>3679.9</td>
</tr>
<tr>
<td>5</td>
<td>Haryana</td>
<td>10137.4</td>
<td>11448.0</td>
<td>11347.7</td>
<td>12123.2</td>
<td>13066.5</td>
<td>13251.5</td>
</tr>
<tr>
<td>6</td>
<td>Karnataka</td>
<td>8645.6</td>
<td>9212.8</td>
<td>8046.8</td>
<td>9935.5</td>
<td>9932.2</td>
<td>10949.0</td>
</tr>
<tr>
<td>7</td>
<td>Kerala</td>
<td>973.6</td>
<td>852.0</td>
<td>797.6</td>
<td>754.5</td>
<td>794.3</td>
<td>772.6</td>
</tr>
<tr>
<td>8</td>
<td>Madhya Pradesh</td>
<td>18072.8</td>
<td>19487.8</td>
<td>17361.9</td>
<td>19499.7</td>
<td>21015.6</td>
<td>8930.4</td>
</tr>
<tr>
<td>9</td>
<td>Maharashtra</td>
<td>11604.3</td>
<td>14602.4</td>
<td>9664.0</td>
<td>12752.8</td>
<td>12607.2</td>
<td>10133.4</td>
</tr>
<tr>
<td>10</td>
<td>Orissa</td>
<td>6802.0</td>
<td>4831.4</td>
<td>6637.8</td>
<td>5793.1</td>
<td>5600.2</td>
<td>4984.8</td>
</tr>
<tr>
<td>11</td>
<td>Punjab</td>
<td>19806.2</td>
<td>21553.3</td>
<td>21143.2</td>
<td>22906.9</td>
<td>25197.8</td>
<td>25318.0</td>
</tr>
<tr>
<td>12</td>
<td>Rajasthan</td>
<td>9567.1</td>
<td>12821.3</td>
<td>14048.9</td>
<td>12944.5</td>
<td>10700.0</td>
<td>10035.8</td>
</tr>
<tr>
<td>13</td>
<td>Tamil Nadu</td>
<td>6405.3</td>
<td>6930.0</td>
<td>8103.8</td>
<td>9418.7</td>
<td>8860.4</td>
<td>8903.4</td>
</tr>
<tr>
<td>14</td>
<td>Uttar Pradesh</td>
<td>38367.5</td>
<td>42385.1</td>
<td>41589.2</td>
<td>40417.2</td>
<td>45238.4</td>
<td>42496.6</td>
</tr>
<tr>
<td>15</td>
<td>West Bengal</td>
<td>12884.8</td>
<td>13756.3</td>
<td>14353.2</td>
<td>14367.2</td>
<td>15067.6</td>
<td>13834.5</td>
</tr>
<tr>
<td></td>
<td>All- India</td>
<td>180415.0</td>
<td>199435.7</td>
<td>219258.7</td>
<td>203544.2</td>
<td>208878.3</td>
<td>195915.9</td>
</tr>
</tbody>
</table>


### PRODUCTIVITY TREND

Land productivity refers to yield per hectare of land. The increase in agricultural production during the last five decades is found in the yield per hectare of land. In India the index number of the yield per hectare has gone up from 64.7 in 1950-51 to 126.6 in 1985-86 and estimated 141.8 in 1995-96. During the first two five year plans, agricultural productivity recorded a continuous growth. From 1961-62 to 1966-67, agricultural productivity was
stagnated. From the year 1967-68 onwards, efforts in the form of new agricultural strategy began to bear fruit; the stagnating trend of agricultural productivity changed its course and the yield per hectare began to increase. During the period 1969-70 to 1996-97 agricultural productivity increased by about 90 percent. This buoyancy has been shared by almost all the major crops. The yield rate of rice has increased from 1797 kgs in 1995-96 to 2086 kgs in 2001-02 except for small dip during 2000-01. The yield rate of sugarcane declined from 68000 kgs in 1995-96 to 66000kgs in 1996-97 and was stagnated with 71000 kgs from 1997-98 to 1999-2000 and again declined to 67000 kgs in 2001-02 from 71000 kgs in 1999-2000.

Production of rice has continuously increased from 77.0 million tonnes in 1995-96 to 89.7 million tonnes in 1999-2000. During 2000-01 and 2001-02, its production has declined to 87.7 million tonnes and 83.1 million tonnes respectively. Production of sugarcane consistently maintained an upward trend except for small dips during 1996-97 and 1997-98. The production of sugarcane increased from 281.1 million tonnes to 300.1 million tonnes in 2001-02.

AGRICULTURAL DEVELOPMENT IN INDIA: POLICIES AND PERSPECTIVES:

Agriculture has been and will continue to be the lifeline of the Indian economy. As the largest private enterprise in India, agriculture contributes nearly one fourth of the national GDP, sustains livelihood of about two thirds of population, and is the backbone of agro based industry. In order to
attain rapid progress in agriculture several strategies have been evolved and executed in India from time to time. These development strategies for agriculture are designed not only to achieve a certain level of output but also to maintain food security and nutritionally desirable composition of output in the country. ‘Community Development’ and ‘National Extension Service’ were started during fifties and with the objectives of attaining rapid development of rural areas. Consequently, programmes like IADP and HYVP have been started by the Government of India during sixties in order to overcome for food crisis.

The agricultural policies followed in India over years can broadly be studied under three phases;

1. Pre – Green Revolution Phase: The Pre – Green Revolution period witnessed several agrarian reforms, institutional changes, development of major irrigation projects (India has the highest dam and the longest manmade canal in the world) and the establishment of input related industries such as fertilizer plants. The intermediary system of landlords was abolished and tenant operations were given security of farming and ownership of land. Land Ceiling Acts were imposed by all states and some even went in for consolidation of holdings to reduce fragmentation. Expansion of area under irrigation for cultivation was the main plank of agricultural growth during the period.

Despite these major initiatives, the country faced a severe food crisis in the early 1960s, which forced the policy makers to realise that
continuous reliance on food imports at heavy cost would result in economic instability and may not be sustainable in the long run. The then prime minister, Mrs. Indira Gandhi gave a call for quick breakthrough in agriculture production. She also laid emphasis on better support for Research and Development in agriculture and strengthened both institutions and human resources to meet the challenge of food security.

2. Green Revolution Phase: Amidst a serious debate, the government took a bold decision to go in for the import and spread of high yielding varieties (HYVs) of wheat and rice which involved intensive use of fertilizers and irrigation. This marked the second phase of agricultural policy. The strategy produced quick results and India witnessed “Green Revolution” the biggest achievement of the new strategy has been the attainment of self sufficiency in foodgrains. Agrarian reforms during this period, however, took a back seat while agricultural research, education, extension, input supply, credit, marketing, price support, procurement, buffer stocking and public distribution system were the main thrusts of policy. Historical decisions like nationalization of commercial banks during this period facilitated an easy credit to priority sector like agriculture.

3. Post – Green revolution Phase: The next phase in policy changes began in the early 1980s. While there was a clear change in economic policy towards delicensing and deregulation in the industrial sector, agricultural policy lacked direction. Agricultural growth, accompanied by increase in
real incomes, led to the emergence of interest groups and lobbies which started influencing farm policy in the country. There was a considerable increase in subsidies and support to the agricultural sector during this period, while public sector spending in agriculture for infrastructure development started showing a decline in real terms (reduced from 18 percent to around 9 percent). But investments by farmers kept increasing. The output growth which was hitherto concentrated in narrow pockets, became broad based and gained momentum.

The rural economy started witnessing a process of diversification in agriculture, which resulted in fast growth in non-foodgrain output such as milk, meat, poultry, fruits, vegetables and fishery. This accelerated the growth in agriculture GDP during the 1980s. This growth seems to be largely market driven and was accomplished through white, yellow and blue revolutions, resulting in major advances in the production of milk, oilseeds, fish and fish products.

The next phase in change of policies in agriculture began in the early 1990s. This was a stage where Indian agriculture moved to a constraint regime, which the country had not been used to historically earlier. The fatigue of the green revolution started becoming visible. It became clear that obtaining the needed incremental food grain production of 5 – 6 million tonnes each year from the conventional green revolution area was rather difficult. The need for a second green revolution, by making grey areas green was felt, that is, by making rainfed areas (still 68 percent) more productive.
Appropriate policy support for capital investment in agriculture including creation of required infrastructure, building of a strong agricultural research and education system coupled with an extension system had helped in achieving the required national confidence to meet the growing food demands despite a growing population. Foodgrain production increased from 72 million tonnes in 1965–66 to a record level of 203 million tonnes in 1998–99 with an annual buffer stock of 20–30 million tonnes during the nineties.\(^\text{13}\)

Similarly, oilseeds production has gone up to 26 million tonnes, potato 25 million tonnes, milk 74 million tonnes and fish 5.38 million tonnes. All these gains are indeed impressive and an outcome of political commitment. Jawaharlal Nehru after independence had stated, “Everything else can wait but not agriculture”. Lai Bahadur Sastri accorded high importance to agriculture next only to defence by coming up with the slogan “Jai Jawan, Jai Kisan”. The historical decision in the sixties to import high yielding varieties of wheat by Mr. C. Subramaniam, the then agriculture minister, which heralded the “Green Revolution”, had been no less visionary. Owing to the vision of such great leaders India achieved the required success in agriculture.

Due to remarkable agricultural transformation made possible by political will, visionary policies sound decision – making, effective policy implementation and the crucial partnership between farmers and scientists, India attained great achievements in agricultural production ie cereals output in India has risen form 80 million tonnes (1966) to 221 mt (1996) an increase

of 176 percent over 30 years. Cereal yields increased by 156 percent over the same period. India became the world’s second largest producer of rice after China. Rice yields increased by 170 percent. India is now the world’s second largest wheat producer, behind China but ahead of the U.S. wheat yields increased by 167 percent\textsuperscript{14}. During the last 50 years, while the rice area has increased only by one and half times from 30 million hectares to about 45 million hectares, the rice production has increased more than four times from 22 million tonnes to 90 million tonnes and the productivity has increased three times from 700 kg/ha to 2000 kg/ha\textsuperscript{15}. Though India attained these remarkable achievements it continues to face formidable problems as follows.

Every minute 48 children are born in India; every minute the population increases by 42 people. 53 percent of India’s children under five years of age are malnutrition and 30 percent of the country’s newborns are of low birth weight. Infant mortality rates are among the highest in the world. The maternal mortality rate of 437 per 1000 births accounts for a quarter of maternal deaths worldwide. More than half of India’s women are anemic. Over 140 million hectares are affected by water and wind erosion. Over a million hectares are damaged each year as a result of shifting cultivation. Environmental issues are mounting falling ground water tables, Stalinisation water pollution, etc. most forests are degraded and productivity is low.

The Nobel Laureate Dr. Norman Borlaug calculated that “to meet projected food demands, by 2025 the average yield of all cereals must be 80

\textsuperscript{14} Survey of Indian Agriculture – 2000. Page – 32.
\textsuperscript{15} Survey of Indian Agriculture – 2004 page – 29
percent higher than the average yield in 1990. This increase will have to be achieved in increasingly complex circumstances." Future increases in food supplies must come primarily from increasing biological yields rather than from area expansion and more irrigation, because land and water are becoming increasingly scarce\textsuperscript{16}. Dr. M.S. Swaminathan in his reply to the question asked by international experts like Dr. Lester Brown of the World Watch Institute has said that, Indian farm families will feed India in another 20 to 30 years provided with immediate steps to conserve and improve our natural resources, particularly land and water, and bridge the gap between potential and actual yields in major farming systems\textsuperscript{17}

In a country like India, where more than 60 percent of the population depends on agriculture for a livelihood becoming an agricultural power is more important in terms of human security than being a nuclear power.

Increasing productivity, employment and income for poor farmers is necessary for agricultural development in the country. Though Indian farmers were the most cost-effective producers in the world, they were being let down by lack of infrastructure, market conditions and unreliable price variations. Thus the uneconomical nature of farming is the single most important cause of the agrarian crisis.

The National Commission on farmers has pointed out that while public policy and investment triggered progress earlier, policy inadequacy and investment decline have taken to farmer suicide and food important era. The

\textsuperscript{16} Survey of Indian Agriculture – 2000, p.31
\textsuperscript{17} Survey of Indian Agriculture – 2000, p.15
challenge of maintaining a balance between human numbers and the capacity to produce food is increasing in India day by day.

The development of agriculture sector has direct impact on the level of farm income as well as national income of a country. Therefore, it is necessary to increase agricultural production. The growth of agriculture is influenced by the various resources such as manures and fertilizers, irrigation facilities, availability of manpower, seeds, bullock labour, working capital, farm implements and machinery, and crop protection etc. The farm income is determined by the efficiency with which farmers are able to utilise the resources at their command. If the farmers are efficient in the use of scarce resources then farmers can increase their income. In Indian agriculture, the availability of resources is not the same all over the country. The optimum allocation of available resources is necessary for the growth of agricultural production.

AGRICULTURE IN TAMIL NADU

Tamil Nadu shares about 6.8 percent of the total population in India while its share in total land area of the country is only 4 percent and its share in the total water resources is about 3 percent of the total water resources in India. In Tamil Nadu, the per capita availability of land is only 0.19 ha while the per capita net sown area is only 0.10 ha. Even though the share of agricultural sector in the state domestic product of Tamil Nadu has declined from about 52 percent to 22 percent between 1960 – 61 and 2000 – 01 agriculture continues to be the major source of livelihood for the rural people.
Agriculture still employs more than 50 percent of the workforce in the state\textsuperscript{18}. Between 1960 – 61 and 2000 – 01, the total cultivated area in Tamil Nadu has decreased by about 14 percent from 7.32 million ha to 6.34 million ha. However, this reduction in cropped area has been more than compensated by the increase in productivity of crops so that higher production has been possible.\textsuperscript{19} The statistics furnished on the various aspects of agricultural growth in Tamil Nadu is presented in appendix I to VII.

Stability in the land use pattern is an index of the health of the agricultural sector. The changes undergone in the pattern of land utilization in Tamil Nadu (Appendix-I) reveals that the net area sown which stood at 40 percent in 1950 – 51 peaked at 47.4 percent in 1970 – 71. After, it declined to 41.2 percent in 1980 – 81 and 35.3 percent in 2002 – 03 due to operation of a multiplicity of factors such as rising population, housing activities, and changing consumption pattern etc.\textsuperscript{20}

Size and number of operational holdings is an index of how the land resources are distributed among the different categories of farming community. In 1979 – 80 out of 72 lakh operational holdings, 75 percent were operated by marginal peasant farmers. But the area operated by marginal farmers stood at 25 percent of 77 lakh hectares in 1979 – 80. The respective percentages were 73 and 29 in 1995 – 96. It indicates not only the agriculture is riddled with relatively higher percentage of marginal farmers

\textsuperscript{19} Ibid
with smaller size of operational holdings, but also the farmers are practicing only subsistence farming at the margin in Tamil Nadu.\textsuperscript{21}

A good Spatio – Temporal distribution of rainfall is imperative for realising a significant step – up in agricultural production and yield. Agriculture still remains a gamble in monsoon because of unpredictability in the behaviour of the monsoon in the state. During the years 1999 – 2000, 2000 – 01 and 2001 – 02, both the north – east and south – west monsoons played truant. In 1999 – 2000, the actual rainfall was 896.8mm against the normal rainfall of 977.5mm leaving a gap of (-) 8.3 percent. In 2000 – 01, the actual rainfall which was deficient by 20 percent was 785.3mm against the normal rainfall of 979.3mm. In 2001 – 02, the rainfall was 795.2mm against the normal rainfall of 974.7mm. In 2002-03, the rainfall was 731.0mm against the normal rainfall of 964.1mm\textsuperscript{22}. In 2003-04, the actual rainfall exceeded the normal rainfall by 7.6 percent\textsuperscript{23}. Due to deviation from the normal rainfall for the three years in succession, there was a wide gap between the capacity of the reservoir and actual quantum of water storage.

Quantum and spread of rainfall has had positive effects on gross and net area sown and cropping intensity. The gross areas sown stood at 58.94 lakh hectares in 1950-51. It went up to 64.69 lakh hectares in 1980-81, but declined to 53.2 lakh hectares in 2003-04. Net area showed which was at 51.52 lakh hectares in 1950-51 rose to 53.60 lakh hectares in 1980-81. It fell down to 46.9 lakh hectares in 2003-04. The cropping intensity which is

\textsuperscript{21}Ibid. Page. 174
\textsuperscript{22}Tamil Nadu – An Economic Appraisal 2001 – 2002 p. 26 – 27.
\textsuperscript{23}S. Manickam,: Economic Development of Tamil Nadu in Perspective – 2006 p.176
symptomatic of efficiency of the land use in agriculture ranged between 113.4 percent in 2003-04 and 123.8 percent in 1970-80. Low cropping intensity is principally due to poor spatio – temporal distribution of precipitation and inadequate irrigation availability because of over exploitation of ground water potential.

Area under food crops increased from 43.07 lakh hectares in 1950-51 to 49.07 lakh hectares in 1980-81, but declined to 24.72 lakh hectares in 2003-04. Area under non-food crops was at 15.87 lakhs hectares in 1950-51 and 14.19 lakh hectares in 2002-03. About three-fourth of the Gross cropped area in Tamil Nadu is utilised for production of food grains. Paddy is the principal crop. Paddy production has increased for 19.3 lakh tonnes in 1950-51 to 57.62 lakh tonnes in the year 1990-91. The area under HYV paddy has substantially increased, more than 90 percent of the area makes use of HYV seeds, fertilizer consumption per hectare of cropped area has substantially increased from 67 kg in 1981-82 to about 115 kg presently. The productivity of rice per hectare which was 1413 kg in 1960-61 has increased to an average of about 2790 kg presently. There had been a slow down as the impact of the new HYV fertilizer technology on crop production. Since 1977-80 because of the limitation to the extension of surface and ground water irrigation, as such crop production in the state is largely isolating with weather conditions.

The other important food crops grown in Tamil Nadu are coarse cereals, pulses etc. In the sixtees and seventies with an increase in the irrigation facility, the area under high value paddy increased at the expense of
the low value cereals. The area under coarse cereals declined during sixtees and the seventees. After sixtees, the area under coarse cereals had shown a tendency to increase.

The pattern of food grains production in Tamil Nadu suggests that while the contribution of rice to the overall production has been more or less steady, the pulses production has recorded a sizeable increase. In respect of the non-food crops, the sugarcane, groundnut and cotton are the important crops grown on commercial lines. However, in both groundnut and cotton instability in production is maked but in sugarcane, the state has made good progress. Any way, the over all trend in agriculture in relation to that of all India statistics showed a declining share of the state in aggregate of crops like food grains, oil seed, cotton etc., while sugarcane is exempted from the above.

Moreover, agriculture in Tamil Nadu appears to have been caught in a quagmire of stagnation during last decade. The cropping pattern has become highly skewed with a distinct shift away from coarse grains and the per capita rural income in the state is among the lowest of many major states in the country. The rice, which is the most important crop of the state, its production has reached a plateau and the demand supply imbalance has been largely met through purchases from other states. Declining area under irrigation, proverbial vagaries of monsoon, rigid cropping pattern, improper use of input systems, poor market infrastructure are the major issues observed in the state.
District level variations with respect to the above are wider and explicit, which needs to be corrected through suitable policies at regional levels.

**THE PROBLEM**

Thus, agriculture in India has been experiencing substantial development during the post independence period, particularly since mid sixtees. The most important of these changes are the wide spread adoption of new HYV seeds, irrigational avenues, use of modern inputs like fertilzer, pesticides and insecticide, tractors, pumpsets and other machineries in crop production. Another redeeming feature of the Indian agricultural is the changes witnessed in the organisational and institutional arrangements for the production, input compositions and distribution of the entire package of inputs available in the system. Moreover, it is also be true that the gains of agricultural production in the last two decades had come essentially from the improved utilisation of the available infrastucture and from the increase in yield per acre, which even helped India to achieve self sufficiency in food grain production. The technological break through coupled with farmers perception on the use of modern inputs and the available extension and their impact on productivity network are believed to be the reasons attributed to this phenomena. However, these changes accorded in crop production and technique are not uniform across crops, farms and regions in the country. It has not only increased the disparities among regions but also has led to uneven distribution of benefits across different size group of farmers between regions. This differential growth is mainly due to the fact that the area under
various agricultural crops have responded differently to techno-economic changes taken place across these regions. Therefore, the issues confronting the cropping system of a country are many and brought the attention of researchers and policy makers debatable. Among the important issues debated in the current phase of agriculture development are the technological issues and the efficiency parameters of farms included in the cropping system of the country. As growing population as well as income enhances the demand for crop products and there is no scope for expanding land frontiers due to the trend in the diversion of agricultural land into non-agricultural purposes, the only option available with the farmers are to increase the crop production through adoption of improved technology and efficient use of available resources. However, agricultural production is largely conditioned by agro-climatic factors as well as technology at regional level, varying levels of input use impress upon the productivity at the farm levels. Yield gap may arise due to sub-optimal or inefficient use of resources. Therefore, examination of variations between the potential and actual yields at farm levels at a given technology and resource endowment of farmers across regions are imperative which would provide a better understanding on the productivity gap at a time when major changes are taken place at macro level policies in the context of economic liberalisation in India. The present study on Resource Use Efficiency in Crop Production: A Comparative Analysis Between Two Ayacuts of the Bhavani River Irrigational Project of Erode District in Tamil Nadu is an attempt on this direction.
OBJECTIVES

The specific objectives of the study are:

1. To identify the socio-economic characteristics of HYV paddy (ADT43) and sugarcane (CO86032) cultivating farmers of various size groups selected from the sample Thadappalli and Lower Bhavani Project Ayacut areas of Erode District.

2. To examine the resource use pattern of paddy and sugarcane cultivating farmers of varying size groups between Thadappalli ayacut and Lower Bhavani Project Ayacut areas and

3. To evaluate the farm level technical efficiencies in the production of paddy and sugarcane between ayacuts viz., Thadappalli and Lower Bhavani Project Ayacuts of Bhavani River Irrigational Project of Erode District in Tamil Nadu.

METHODOLOGY

SELECTION OF SAMPLE HOUSEHOLDS

Erode District of Tamil Nadu has been selected for the study, considering the predominance of agriculture as a source of livelihood to vast population and the significances of this study to serve as a model to be replicated to other regions of the state. Therefore, the district form the universe of the study. Erode district is divided into three revenue divisions viz., Erode, Gobichettipalayam and Dharapuram. Of these, Gobichettipalayam Revenue division was purposively selected for the study based on its specific agro-climatic features, extent of area under canal
irrigation, cropping pattern, irrigation intensity and other socio-economic characteristics. River Bhavani is the single most river irrigating the district on a larger scale. It has 4 ayacuts viz., Thadappalli, Arakkan Kottai, Kalingarayan and Lower Bhavani. Out of the four ayacuts, two ayacuts of the Bhavani River basin viz., Thadappalli canal and Lower Bhavani Project canal were purposively selected for this study on the basis of their prominence over other project areas in cultivating both HYV paddy and sugarcane simultaneously over long period. 12 villages in each ayacut were randomly selected in such a way that each village is situated within the periphery of the ayacuts concerned. A complete enumeration of all the households in the selected villages were done so as to identify their occupational pattern, level of operational holdings, cropping pattern, the extent of area under cultivation of paddy / sugarcane and other socio-economic features suitable to the study. A total of 480 farmer households cultivating paddy and sugarcane in an area of 50% or more of their total cropped area were selected from the 24 villages giving equal representation to all sample villages. Then the selected farmers were classified into four major size groups through post-stratification. Thus, the selection of sample is based on purposive –cum two stage stratified random sampling procedure. The present study is confined to a total sample of 480 Paddy / sugarcane cultivating farmer households, selected from 24 villages of the two prominent ayacut areas viz., Thadappalli, and Lower Bhavani Project of the Bhavani River Basin in Erode District of Tamil Nadu, as presented below.
DATA

The detailed data on the parameters relating to the socio-economic characteristics and input-output parameters of HYV paddy (ADT43) and sugarcane (CO86032) production were collected from the sample of 480 farmers cultivating paddy / sugarcane of major crops by using a well structured and field tested schedule. The data were collected through personal survey method, during the respective crop seasons applicable to the crop year 2004-05. The primary data on input-output systems obtained from sample farmers were duly standardised and included for estimation.
The actual quantity of seed used per acre by sample farmers were used as a measure. Family labour was measured by taking into account the no. of hours participation by family members viz., male and female labour was converted into standard man-days. The actual no. of hired labour employed by sample farmers for different operations during the whole crop period was taken as a measure of hired labour. As ploughing was observed to be a measure of improving soil fertility which was carried by most of the sample farmers through tractors starting from seedling to harvest, the actual hours utilised in terms of cost was computed as a measure. As organic manure seemed to be a scarce input for majority of farmers, the actual chemical fertilizer used for the crop period was derived from the sample farmers and included. The actual cost of pesticide components used by farmers were obtained and included. As the variable capital cost (DIRTI-5) and miscellaneous spending by farmers do not in any way linked up with direct production, these variables were excluded from estimation. The output variables viz., HYV paddy and sugarcane were calculated on per acre basis for the period under study. The secondary information’s relating to the study were collected from the published and unpublished sources available in the State and Central levels.

ANALYTICAL METHODOLOGY

Functional Analysis to understand crop production relationships has mostly concentrated on resources use efficiencies, technical and technological change to increase productivity. Large number of studies based
on the above approaches are available in India and elsewhere. Of the various approaches to the estimation of technical efficiency, the Stochastic Frontier Production Function\textsuperscript{24} is the most popular approach considered in recent years. Review of the literature from many studies too has suggested that stochastic production function with a composed error term is more appropriate than the other models like the deterministic frontier models to estimate technical efficiency in agriculture, particularly in the developing countries where the probability of data being influenced by measurement errors and agro-climatic conditions are high. The stochastic frontier (Bhende and Kalirajan)\textsuperscript{25} has been modelled with a composite error term, comprising two components. A symmetric component permits random variation of the frontier across firms and captures the effects of measurement error other statistical noise and random shocks outside the firms control. A one sided component captures firm-specific effects such as slackness in production due to labour shirking, which are under the control of the firms and influence their level of achievement of technical efficiency. For the present analysis, the empirical model used for analysis consists of two stages. In the first stage, farm specific technical efficiency scores are estimated using stochastic production function, of the following type;

$$\ln (Y_i) = X_i \alpha + V_i - U_i \hspace{1cm} \text{(1)}$$


Where \( Y \) is the dependent variable (output) and \( X_i \) are the independent variables viz., area under crop, seed, family labour, hired labour, machine hours, chemical fertilizer and pesticide cost. In this model, the dependent variable is bounded by the stochastic variable, \( V_i - U_i \). The random error, \( V_i \) can be positive or negative and so the stochastic outputs vary about the deterministic part of the frontier model.

\( V_i \) is the symmetric random error term distributed independently and identically \( N (0, \sigma_v^2) \) and captures errors beyond the farmer's control. \( U_i \) is the one-sided production, distributed independently and identically with non-negative truncation of the normal distribution \( N (0, \sigma_v^2) \). If the farm is inefficient (efficient), the actual output produced is less than (or equal to) the potential output. Therefore, the ratios of actual output and potential output can be treated as a measure of technical efficiency. Using the above equation 1, the technical efficiency (TE) of the \( i^{th} \) farm is derived as: 

\[
TE_i = \exp (-U_i)
\]

The technical efficiency of the \( i^{th} \) farmer \((TE_i = \mu_i)\) is derived from the density function of \( u \) and \( v \) which can be written as

\[
F_u (u) = \frac{1}{\sqrt{\frac{1}{2}\pi}} \cdot \frac{1}{\sigma_u} \cdot \exp \left\{ -\frac{u^2}{2\sigma_u^2} \right\} \text{ for } u \leq 0 \quad \text{-------------(2)}
\]

\[
= 0 \text{ otherwise}
\]

\[
F_v (v) = \frac{1}{\sqrt{\frac{1}{2}\pi}} \cdot \frac{1}{\sigma_v} \cdot \exp \left\{ -\frac{v^2}{2\sigma_v^2} \right\} \text{ for } -\infty \leq u \leq \infty \quad \text{-----------(2a)}
\]

The density function of \( y \) is the joint density function of \((u+v)\) and is given by

\[
F_\nu (y) = \frac{\pi}{\sqrt{\frac{1}{2}\pi}} \cdot \frac{1}{\sigma} \cdot \exp \left\{ \frac{(u+v)^2}{2\sigma^2} \right\} \cdot 1 - f \left\{ \frac{(u+v)}{\sigma} (\gamma / 1 + \gamma) \right\} \quad \text{-------------------------------------------3}
\]

32
Where,

\[ \sigma^2 = \sigma_u^2 + \sigma_v^2 \] ................................................................. 4

\[ \gamma = \frac{\sigma_u^2}{\sigma^2}, \quad 0 \leq \gamma \leq 1 \] ................................................................. 4a

Finally, \( \gamma \) is given by

\[ \sigma_{ui} = -\sigma_u \sigma_v / \sigma \left[ \{ \varphi (\cdot)/1-\varphi (\cdot) \} - \{ ((u+v)/\sigma) \sqrt{(u/v)} (1/v) \} \right] \] ................. 5

where \( \varphi (\cdot) \) and \( \varphi (\cdot) \) are standard density and distribution functions, respectively. The variables specified for estimation of Technical Efficiency for the individual farms and crops based on Cobb-Douglas type was;

\( y \) = output of crops (paddy / sugarcane / in quintal / acre)

\( X_1 \) = seed rate in kg/acre

\( X_2 \) = Area under crop (in acres)

\( X_3 \) = Family labour (male + female) man-days/acre.

\( X_4 \) = Hired labour used in man-days/acre

\( X_5 \) = Cost on machine hours used in Rs. / acre

\( X_6 \) = Quantity of chemical fertilizer used in kg/acre

\( X_7 \) = Cost on pesticide components (in Rs./acre)

**DETERMINANTS OF TECHNICAL EFFICIENCY**

As crop output is conditioned by the factors like rainfall, incidence of disease & pest, soil fertility and other socio-economic factors, a simple linear regression technique of the following type was used to identify the factors that influence the technical efficiency of the selected farmer households. The technical efficiency scores generated by the frontier are regressed on the independent variables as follows;
\[ T_{E_{ij}} = \alpha + a_1 (X_1) + a_2 (X_2) + a_3 (X_3) + a_4 (X_4) + e_i \]

Where,

- \( T_{E_{ij}} \) = level of technical efficiency estimated through MLE
- \( X_1 \) = Age
- \( X_2 \) = Educational status
- \( X_3 \) = Farm size
- \( X_4 \) = Family Size
- \( a_1 \ldots a_4 \) = regression co-efficients
- \( e_i \) = error term
- \( \alpha \) = constant

**PERIOD OF THE STUDY**

The duration of the study was 8 years from November 1999 to October 2007, and the primary data required for the study were collected for 2004-2005 crop year.

**LIMITATIONS**

1. This study was confined to the Thadappalli and Lower Bhavani Project areas of Gobichettipalayam Revenue Division in Erode District and hence the conclusion drawn would largely applicable to these regions and the crops viz., HYV ADT43(paddy) and CO86032 (sugarcane) only and may not be valid for other region in the state.

2. Since primary data needed for the study were collected through survey method, which involves recall bias, experimental accuracy cannot be expected in the data generated for the study. However, care has been taken to minimize the bias through check questions.

3. Moreover, a cross-section survey covering two crop seasons may have its own limitations for exploration of findings.
DESIGN OF THE STUDY

The first chapter of the study highlights the importance of the problem, choices of the study area and outlines the objectives, methodology, selection of sample, sources of data, analysis used, period of study, limitations and design of the study. An overall review of the related studies conducted earlier is attempted in the second chapter. The profile of the study area, concepts used and their measurement are presented in chapter three.

The fourth chapter deals with the results of the study viz., socio-economic characteristics of the sample farmers, economics of crop production among sample farmer households by farm size and technical efficiency in crop production for the selected sample farms in the areas. The summary and conclusion of the study are presented in chapter five.