A STUDY ON TREND AND DETERMINANTS OF AGRICULTURAL PRODUCTIVITY: AN INTER – DIVISIONAL ANALYSIS IN CHITTOOR DISTRICT (ANDHRA PRADESH)

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ABSTRACT

There are number of studies on the agricultural sector in Chittoor district. But the research on trends and determinants of agricultural productivity is scanty. Hence the empirical, scientific, inductive, factor-finding investigational study on agricultural productivity in the rural economy of Chittoor district is an important phenomena. This paper aims to determine the trend in agricultural productivity in Chittoor District. Also, identify and analyse the important factors determining the agricultural productivity in three revenue divisions of Chittoor District, Andhra Pradesh. It is proposed to study the trend in agricultural productivity for entire district as a whole. The function has been developed to determine the trend. At present, the productivity trend is calculated for the period 1978-79 to 1997-98. To avoid the risk in productivity, observations are considered as the average of three years productivity (Triennium period). The trend is calculated for triennium period. To determine the effect of some identified variables on agricultural productivity, multiple regression analysis is utilized. Seven variables were identified as the determinants of productivity in Chittoor district. The district is divided into 3 revenue divisions namely, Chittoor, Tirupati and Madanapalle and the functional relation is established to these divisions and the entire district as a whole as one unit. The data is collected for the dependent variable agricultural productivity, crop wise, (i.e., six major crops namely, paddy, jowar, bajra, ragi, groundnut and sugarcane) in each mandal from un published records, hand book of statistics, issued by the district Chief Planning Officer, Chittoor district. The average yield of these six major crops, in terms of rupees, is considered as the agricultural productivity. The data related to independent variables is collected from the same records. In case of Chittoor district as a whole, the observed and expected relationships of the explanatory variables – percentage of irrigated area, average size of operational holding and percentage of hired workers are coinciding with the explained variable agricultural productivity. The remaining four variables establishing the negative and significant relationship with agricultural productivity. The observed negative relationship is contradictory to the expected positive relationship. Further, the same was calculated separately for the three selected revenue divisions of Chittoor District.

KEYWORDS: Agricultural Productivity, Actual Annual Rainfall, Percentage of Irrigated Area, Average Size of Operational Holding, Land Concentration Ratio, Workers-Area Ratio, Percentage of Hired Workers, Fertilizers and Pesticides Consumption per Acre

INTRODUCTION

The term agricultural productivity we mean the varying relationship between the agricultural output and one of the major input such as land. The most commonly used term for representing agricultural productivity is the average yield per hectare of land. After the introduction of modern agricultural techniques along with the adoption of hybrid seeds, extension of irrigation facilities and application of intensive methods of cultivation in India, yield per hectare of all crops has recorded a steep rising trend. Agricultural productivity in India has undergone an abrupt change in the Post-Green Revolution period. But the fruits of green revolution were mostly available to some particular states only, as the
introduction of new agricultural strategy was very much restricted into some particular states like Punjab, Haryana and Western Uttarpradesh. Thus while the agricultural productivity in all other states remained more or less static or increased slowly but the agricultural productivity of some crops in those particular states adopting new agricultural strategy has increased substantially. All these had led to a high degree of inter-state differences in agricultural productivity in the country.

The condition of Indian agriculture still largely remains backward although it is considered as the backbone of the Indian economy. Agriculture productivity which is composed of both productivity of land and labour as well, is among the lowest in the world. Average yield per hectare in India is quite below the world average in all crops. It is much lower as compared with even the yield rates prevailing in less advanced countries of the world. With the introduction of economic planning in India, although some steps have been undertaken for improving the conditions of agriculture, its conditions have not changed much. Hence it is quite essential to analyse the various factors which are responsible for the backwardness of Indian agriculture.

In India, agricultural sector is very much over crowded. Too many people of India depend on agriculture. Various socio-economic factors like farmer’s conservative outlook, ignorance, illiteracy, superstition, etc., stand in the way of adoption of modern technology in Indian agriculture. Nature still dominates agriculture in this country. It is said to be a gamble of monsoons. Other natural calamities such as hail storm, frost or attack by pest and insects are also of common occurrence in India. Indian agriculture still remains backward due to its inadequate financial provision. Besides all these factors some institutional and technological factors always go against the Indian farmers in stepping up their agricultural productivity.

The consolidation of holdings, proper steps to overcome various problems of agriculture resulted from natural factors, application of modern techniques of cultivation and some economic measures, human development are the important and necessary measures for improving the agricultural sector and for raising agricultural productivity in India. There are number of studies on the agricultural sector in Chittoor district. But the research on trends and determinants of agricultural productivity is scanty. Hence the empirical, scientific, inductive, factor-finding investigational study on agricultural productivity in the rural economy of Chittoor district is an important phenomena. Hence an attempt is made to study the trend and determinants of agricultural productivity in three revenue divisions of Chittoor district, Andhra Pradesh.

OBJECTIVES

The following are the objectives of the study:

- To determine the trend in agricultural productivity in Chittoor District.
- To identify and analyse the important factors determining the agricultural productivity in three revenue divisions of Chittoor District, Andhra Pradesh.

METHODOLOGY

It is proposed to study the trend in agricultural productivity for entire district as a whole. The function which is used to determine the trend is,

\[ Y = a + bt \]  \hspace{1cm} (1)

Where,
A Study on Trend and Determinants of Agricultural Productivity: An Inter – Divisional Analysis in Chittoor District (Andhra Pradesh)

Y = Agricultural productivity

t = Time in years

a and b are the constants

At present, the productivity trend is calculated for the period 1978-79 to 1997-98. To avoid the risk in productivity, observations are considered as the average of three years productivity (Triennium period). The trend is calculated for triennium period. To determine the effect of some identified variables on agricultural productivity, multiple regression analysis is utilized. Seven variables were identified as the determinants of productivity in Chittoor district. The district is divided into 3 revenue divisions namely, Chittoor, Tirupati and Madanapalle and the functional relation is established to these divisions and the entire district as a whole as one unit.

The data is collected for the dependent variable agricultural productivity, crop wise, (i.e., six major crops namely, paddy, jowar, bajra, ragi, groundnut and sugarcane) in each mandal from un published records, hand book of statistics, issued by the district Chief Planning Officer, Chittoor district. The average yield of these six major crops, in terms of rupees, is considered as the agricultural productivity. The data related to independent variables is collected from the same records. Among the number of factors which are affecting the agricultural productivity, seven variables are considered as the important variables. The impact of these seven variables are grouped under the following heads.

Rainfall and irrigation have been considered to indicate the impact of availability and utilization of water supply. Holding-size and concentration ratio have been taken to reflect the average size and distribution pattern of land. The strength of workers per acre and the ratio of hired workers to total workers indicate the impact of labour force associated with cultivation. Consumption of fertilizers and pesticides per acre reflect the fertility of soil, it also affects the agricultural productivity.

The relative impact of seven selected variables on agricultural productivity is analysed by the multiple regression analysis. The regression equation is of the form,

\[ Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7) \]  

Specifically,

\[ Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 \]  

Where, \( a_1, a_2, a_3, a_4, a_5, a_6 \) and \( a_7 \) are the co-efficients of independent variables, \( a_0 \) is the constant or intercept. The combined effect of independent variables on agricultural productivity is carried out by multiple correlation co-efficient and is tested for its significance by the F-test statistic. T-test statistic is calculated for significance of each independent variable on productivity. The specification of the variables are given as follows:

Agricultural Productivity (Y)

For the present research purpose, six major crops are selected. Initially, the production of each crop in each mandal is collected. The crop production is multiplied by average price of the particular crop. The average productivity of the crop in each mandal is computed i.e.,

\[ Y = \frac{\sum_{i=1}^{6} \text{Total Agricultural Production of Each Crop} \times \text{Average Price}}{\sum_{i=1}^{6} \text{Total Area Under the Crops}} \]  

(or) \[ Y = \frac{\sum_{i=1}^{6} q_i p_i}{\sum_{i=1}^{6} a_i} \]
**Actual Annual Rainfall (in mms.)** $(X_1)$

Generally, it is accepted that as rainfall increases the productivity also increases. Hence, the positive relation is expected between these two variables.

**Percentage of Irrigated Area** $(X_2)$

The variable ‘percentage of irrigated area’ influences the agricultural productivity. Generally, the increase in the percentage of irrigated area will increase the agricultural productivity. There is a positive relationship between agricultural productivity and percentage of irrigated area.

\[ X_2 = \frac{\text{Gross area irrigated}}{\text{Gross area sown}} \times 100 \]

**Average Size of Operational Holding** $(X_3)$

Average size of operational holding is calculated by net area sown divided by number of agricultural households. It is expected that, as the size of operational holding increases the agricultural productivity decreases. Therefore, a negative relationship between these two variables may be established.

\[ X_3 = \frac{\text{Net area sown}}{\text{No. of Agricultural households}} \]

**Land Concentration Ratio** $(X_4)$

The ratio between net area sown and total population is land concentration ratio. Theoretically, positive relationship is expected between land concentration ratio and the agricultural productivity.

This is because higher the concentration ratio, higher will be the area concentrated in large size holdings since higher material inputs and better management of the large sized holdings lead to higher productivity levels.

\[ X_4 = \frac{\text{Net area sown}}{\text{Total population}} \]

**Workers – Area Ratio** $(X_5)$

The ratio between total workers and net area sown in workers-area ratio. It is assumed that there is a positive relationship between workers-area ratio and agricultural productivity. As number of workers increases, the productivity also increases.

\[ X_5 = \frac{\text{Total workers}}{\text{Net area sown}} \]

**Percentage of Hired Workers** $(X_6)$

Percentage of hired workers is the ratio of hired worker to the total agricultural workers multiplied by hundred. A positive relationship is expected between the percentage of hired workers and the agricultural productivity since the hired workers are skilled labourers.

\[ X_6 = \frac{\text{Hired workers}}{\text{Total Agricultural workers}} \times 100 \]
Fertilizers and Pesticides Consumption per Acre ($X_7$)

Generally, there is a positive relationship between the agricultural productivity and fertilizers and pesticides consumption per acre. This is calculated by total consumption of fertilizers and pesticides in each mandal divided by the gross area sown in the mandal.

$$X_7 = \frac{\text{Total consumption of fertilizers and pesticides}}{\text{Gross area sown}}$$

In the present study, the relevant secondary data for explanatory and explained variables is collected from the Census of India 1991: Population Census and also from handbook of statistics and other unpublished official records of the Chief Planning Officer, Chittoor. The primary data required is collected through field survey: 1998-99.

RESULTS & DISCUSSIONS

The ratio between output and some of the inputs is known as productivity, in agricultural sector, total agricultural output divided by the land units, generally called as agricultural productivity. This is also known as average yield per unit of land. This average yield is affected by the numerous factors. Among these factors, the quantitative interpretations, these factors are considered. In special cases some qualitative variables (Dummy variables) may also be considered. In the present study, these dummy variables are not considered. The trend in agricultural productivity is calculated by simple regression analysis considering the time factor (Years) as independent variable and productivity (rupees) as dependent variable.

Trend in Agricultural Productivity

The estimated linear equation of agricultural productivity in Chittoor district is

$$Y = 301.16 + 337.9^* t$$

(21.8687)

$$r = 0.9662, \text{ LGR} = 9.18$$

* Significant at 5 percent probability level

Figure 1: Chittoor District: Agricultural Productivity

From the above equation the co-efficient of ‘t’ i.e., the value of ‘b’ is 337.9. It reveals that there is an increasing trend in agricultural productivity in Chittoor district. It means an average of 337.9 rupees of agricultural productivity is increasing every year during the study period. But this increase is significant. The effect of time on agricultural productivity is shown by the value of ‘r’. The value of ‘r’ is 0.9662. It indicates that 96.62 percent of variation is observed by the time factor. The linear growth rate is 9.18 percent. This shows that the average annual increase in agricultural productivity in Chittoor district is 9.18 percent. The value of intercept term is 301.16.
Determinants of Agricultural Productivity

The following variables are affecting the agricultural productivity and are considered in the present study. Actual annual rainfall (in.mms), percentage of irrigated area, average size of operational holding, land concentration ratio, workers-area ratio, percentage of hired workers, Fertilizers and pesticides consumption per acre. The expected relationship of each explanatory variable with the explained variable is given in the following table.

Table 1: Type of the Variable and Expected Relation

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description of Variables</th>
<th>Type of Variable</th>
<th>Expected Relationship with Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>Agricultural productivity</td>
<td>Explained</td>
<td>-</td>
</tr>
<tr>
<td>X₁</td>
<td>Actual Annual rainfall (in.mms.)</td>
<td>Explanatory</td>
<td>Positive</td>
</tr>
<tr>
<td>X₂</td>
<td>Percentage of irrigated area</td>
<td>Explanatory</td>
<td>Positive</td>
</tr>
<tr>
<td>X₃</td>
<td>Average size of operational holding</td>
<td>Explained</td>
<td>Negative</td>
</tr>
<tr>
<td>X₄</td>
<td>Land concentration ratio</td>
<td>Explanatory</td>
<td>Positive</td>
</tr>
<tr>
<td>X₅</td>
<td>Workers – area ratio</td>
<td>Explanatory</td>
<td>Positive</td>
</tr>
<tr>
<td>X₆</td>
<td>Percentage of hired workers</td>
<td>Explanatory</td>
<td>Positive</td>
</tr>
<tr>
<td>X₇</td>
<td>Fertilizers and pesticides consumption per acre</td>
<td>Explanatory</td>
<td>Positive</td>
</tr>
</tbody>
</table>

The equation is fed with the collected data for each revenue division and the district as a whole. The estimated regression equations for each division is given and analysed accordingly.

Chittoor Division

The estimated regression equation of Chittoor division is

\[ Y = 192.4515 -1.2741 \times X₁ + 15.9234 \times X₂ + 1577.6547 \times X₃ + 249.1199 \times X₄ - 57.0737 \times X₅ - 99.5297 \times X₆ - 7.3059 \times X₇ \]

\[
(0.1078) \quad (1.4467) \quad (78.7934) \quad (17.2032) \quad (74.4144) \quad (2.1837) \quad (0.1058)
\]

\[ R^2 = 0.3814, \quad F = 3.43 \]

*Significant at 5 percent probability level.

Figures in the parentheses are the standard errors of the estimates.

The estimated regression co-efficient of annual rainfall (X₁) is negative. By t-test statistic this estimated co-efficient is significant at 5 percent probability level. It reveals that an increase in one unit of rainfall will decrease the agricultural productivity by 1.27 units. This decrease is significant. The negative and significant co-efficient reveals that there is some scope to raise the productivity by providing irrigation facilities. Untimely rains/irregular rains will also lead to the decrease in agricultural productivity. Hence, the agricultural productivity will be raised by providing sufficient irrigation facilities. It also reveals that, there is excess rainfall in Chittoor division. The co-efficient of percentage of irrigated area (X₂) is positive and significant. An increase in one unit of X₂ variable will increase the agricultural productivity by 15.92 units. This increase in productivity due to X₂ variable is significant. The co-efficient of average size of operational holding (X₃) is positive and significant. An increase in one unit of X₃ variable will increase the agricultural productivity by 1577.65 units. This increase in productivity due to X₃ variable is significant. The co-efficient of land concentration ratio (X₄) is positive and significant. An increase in one unit of X₄ variable will raise the agricultural productivity by 249.12 units. This increase in productivity due to X₄ variable is significant.

The co-efficient of workers-area ratio (X₅) is negative and insignificant. It reveals that an increase in one unit of X₅ variable will decrease the agricultural productivity by 57.07 units. This decrease is not significant at 5 percent probability level. The co-efficient of percentage of hired workers (X₆) is negative and significant. It reveals that an increase in one unit of X₆ variable will reduce the productivity by 99.53 units. This decrease is significant. The negative and
significant co-efficient reveals that there is some scope to raise the agricultural productivity by increasing the percentage of hired workers. It may be concluded that the agricultural productivity will be raised by increasing the hired workers in Chittoor division. It also reveals that the percentage of hired workers in this division is not sufficient. The co-efficient of fertilizers and pesticides consumption per acre (X7) is negative and significant. It reveals that an increase in one unit of X7 variable will decrease the agricultural productivity by 7.31 units. This decrease is significant. The negative and significant co-efficient reveals that, there is some scope to raise the productivity by increasing the consumption of fertilizers and pesticides. It may be concluded that the agricultural productivity will be raised by increasing the units of X7 variable. It also reveals that the consumption of fertilizers and pesticides in Chittoor division is not sufficient.

The multiple correlation co-efficient (R²) is the collective effect of all independent variables on the dependent variable. The value of R² is 0.3814. It means 38.14 percent of variation is observed in agricultural productivity by all independent variables in this division. From F-test statistic this percentage of variation is significant at 5 percent probability level.

**Tirupati Division**

The estimated regression equation of Tirupati division is

\[ Y = 202.4936 - 7.3851X_1 - 51.7501X_2 - 1062.2149X_3 - 778.1399X_4 - 1353.0625X_5 + 71.4346X_6 + 6.4509X_7 \]

(0.0294) (0.7167) (39.7585) (11.7702) (18.0569) (0.4989)

\[ R^2 = 0.9046 \quad F = 4.504^* \]

* Significant at 5 percent probability level.

Figures in the parentheses are the standard errors of the estimates.

The estimated regression co-efficient of annual rainfall (X1) is negative. By t-test statistic, the estimated co-efficient is significant at 5 percent probability level. It reveals that an increase in one unit of X1 variable will decrease the agricultural productivity by 7.38 units. This decrease is significant. The negative and significant co-efficient reveals that, there is some scope to increase the productivity by providing adequate irrigation facilities. It may be concluded that the agricultural productivity will be raised by providing adequate irrigation facilities. It also reveals that there is excess rainfall in Tirupati division.

The co-efficient of percentage of irrigated area (X2) is negative and significant. It reveals that an increase in one unit of X2 variable will decrease the agricultural productivity by 51.75 units. This decrease is significant. The negative and significant co-efficient reveals that there is possibility to raise the productivity by providing the additional irrigation facilities. Hence, agricultural productivity will be raised by increasing the irrigation facilities and it also reveals that the irrigation facilities in Tirupati division is comparatively less. The co-efficient of average size of operational holding (X3) is negative and significant. An increase in one unit of X3 variable will reduce the agricultural productivity by 1062.21 units. This decrease is significant. The negative and significant co-efficient reveals that the existence of possibility to raise agricultural productivity by decreasing the size of operational holding. It may be concluded that the agricultural productivity will be raised by reducing the size of operational holding. It also reveals that the average size of operational holding in Tirupati division is not an optimum.

The co-efficient of land concentration ratio (X4) is negative and significant. It reveals that an increase in one unit of X4 variable will decrease the agricultural productivity by 778.14 units. This decrease is significant. The negative and significant co-efficient reveals that there is some scope to raise the productivity by increasing the concentration ratio. Hence, agricultural productivity will be raised by increasing the units of X4 variable. It also reveals that land concentration ratio in Tirupati division is not adequate.
The co-efficient of workers-area ratio ($X_5$) is negative and significant. It reveals that an increase in one unit of $X_5$ variable will decrease the agricultural productivity by 1353.06 units. This decrease in productivity due to $X_5$ variable is significant. The negative and significant co-efficient reveals that, there is chance to raise the agricultural productivity by increasing the workers – area ratio. It may be concluded that the agricultural productivity will be raised by increasing the units of $X_5$ variable. It also reveals that workers – area ratio in Tirupati division is not sufficient.

The multiple correlation ($R^2$) is the collective effect of all independent variables on dependent variable. The value of $R^2$ is 0.9046. It means 90.46 percent of variation is observed in agricultural productivity. From F-test statistic this percentage of variation is significant.

**Madanapalle Division**

The estimated regression equation of Madanapalle division is

$$Y = 93.6903 - 0.4247X_1 - 40.3496X_2 + 1337.4312X_3 - 909.7139X_4 + 47.8601X_5 + 77.0246X_6 + 9.6504X_7$$

$$R^2 = 0.4517, \ F = 1.1876^*$$

* Significant at 5 percent probability level.

Figures in the parentheses are the standard errors of the estimates.

The estimated regression co-efficient of annual rainfall ($X_1$) is negative. By t-test statistic this estimated co-efficient is significant at 5 percent probability level. It reveals that an increase in one unit of $X_1$ variable will decrease the agricultural productivity by 0.42 units. This decrease is significant. The negative and significant co-efficient reveals that there is some scope to raise the productivity by providing adequate irrigation facilities. It may be concluded that the agricultural productivity will be raised by providing sufficient irrigation facilities. It also reveals that there is excess rainfall in Madanapalle division.

The co-efficient of percentage of irrigated area ($X_2$) is negative and significant. It reveals that an increase in one unit of $X_2$ variable will decrease the agricultural productivity by 40.35 units. This decrease is significant. The negative and significant co-efficient reveals that there is a chance to raise the productivity by providing the additional irrigation facilities. It may be concluded that the agricultural productivity will be raised by increasing the irrigation facilities. It also reveals that the irrigation facilities in Madanapalle division are less.

The co-efficient of average size of operational holding ($X_3$) is negative and significant. It reveals that an increase in one unit of $X_3$ variable will reduce the agricultural productivity by 1062.21 units. This decrease is significant. The negative and significant co-efficient reveals that there is a chance to raise the agricultural productivity by decreasing the size of operational holding. Hence, agricultural productivity will be raised by reducing the units of $X_3$ variable. It also reveals that the size of operational holding is not encouraging to increase the agricultural productivity in the division.

The co-efficient of land concentration ratio ($X_4$) is negative and significant. It reveals that an increase in one unit of $X_4$ variable will decrease the agricultural productivity by 778.14 units. This decrease is significant. The negative and significant co-efficient reveals that there is some scope to increase the productivity by increasing the concentration ratio. It may be concluded that the agricultural productivity will be raised by increasing the units of $X_4$ variable. It also reveals that
the land concentration ratio in Madanapalle division is not sufficient. The co-efficient of workers-area ratio (X₃) is positive and significant. An increase in one unit of X₃ variable will raise the agricultural productivity by 47.86 units. This increase in productivity due to X₃ variable is significant. The co-efficient of percentage of hired workers (X₆) is positive and significant. An increase in one unit of X₆ variable will increase the agricultural productivity by 77.02 units.

This increase in productivity due to X₆ variable is significant. The co-efficient of fertilizers and pesticides consumption per acre (X₄) is positive and significant. An increase in one unit of X₄ variable will increase the agricultural productivity by 9.65 units. This increase in productivity due to X₄ variable is significant.

The combined effect of all explanatory variables on explained variable is 0.4517. It means 45.17 percent of variation is observed in agricultural productivity. From F-test statistic, the percentage of variation is not significant.

**Chittoor District**

The estimated regression equation of Chittoor District is

\[
Y = 214.9614 - 7.5046 X₁ + 11.3370 X₂ - 1124.4717 X₃ - 351.5408 X₄ - 2544.3893 X₅ + 93.4706 X₆ - 5.5959 X₇ \\
(0.0183) (0.3369) (8.6856) (4.0161) (14.6257) (0.6409) (0.0547)
\]

\[R^2 = 0.5932 \quad F = 4.498\]

* Significant at 5 percent probability level.

Figures in the parentheses are the standard errors of the estimates.

The estimated regression co-efficient of annual rainfall (X₁) is negative and significant at 5 percent probability level. It reveals that an increase in one unit of rainfall will decrease the agricultural productivity by 7.50 units. But this decrease is significant. The negative and significant co-efficient reveals that there is some scope to raise the productivity by providing irrigation facilities. It may be concluded that the agricultural productivity will by raised by providing sufficient irrigation facilities. It also reveals that there is excess rainfall in Chittoor district. The co-efficient of percentage of irrigated area (X₃) is positive and significant. It means an increase in one unit of X₃ variable will increase the agricultural productivity by 11.34 units. This increase in productivity due to X₃ variable is significant.

The co-efficient of average size of operational holding (X₄) is negative and significant. It reveals that an increase in one unit of X₄ variable will decrease the agricultural productivity by 1124.47 units. This decrease is significant. The negative and significant co-efficient says that there is a chance to raise agricultural productivity by decreasing the size of operational holding. It may be concluded that the agricultural productivity will be raised by reducing the size of holding. It also reveals that the size of operational holding in Chittoor district is not an optimum.

The co-efficient of land concentration ratio (X₅) is negative and significant. It reveals that an increase in one unit of X₅ variable will decrease the agricultural productivity by 778.14 units. This decrease is significant. The negative and significant co-efficient reveals that there is a chance to increase the productivity by increasing the concentration ratio. Hence, agricultural productivity will be raised by increasing the units of X₅ variable. It also reveals that land concentration ratio in Chittoor district is not an optimum. The co-efficient of workers–area ratio (X₆) is negative and significant.

It reveals that an increase in one unit of X₆ variable will decrease the agricultural productivity by 2544.39 units. This decrease is significant. The negative and significant co-efficient reveals that there is some scope to raise the productivity by more workers–area ratio. It may be concluded that the agricultural productivity will be raised by increasing the units of X₆ variable. It also reveals that there exist an adequate workers–area ratio in Chittoor district. The co-efficient of percentage of hired workers (X₇) is positive and significant. It means an increase in one unit of X₇ variable will raise the
agricultural productivity by 93.47 units. This increase in productivity due to $X_6$ variable is significant.

The co-efficient of fertilizers and pesticides consumption per acre ($X_7$) is negative and significant. It reveals that an increase in one unit of $X_7$ variable will reduce the agricultural productivity by 5.59 units. This decrease is significant. The negative and significant co-efficient reveals that there is a chance to raise agricultural productivity by increasing the consumption of fertilizers and pesticides. It may be concluded that the agricultural productivity will be raised by increasing the units of $X_7$ variable. It also reveals that consumption of fertilizers and pesticides in Chittoor district is not sufficient. The combined effect of all independent variables on dependent variable is shown by $R^2$. The value of $R^2$ is 0.5932 (in case of Chittoor district as a whole). It means 59.32 percent of variation is observed in agricultural productivity. From F-test statistic, this variation is significant.

The estimated co-efficient of actual annual rainfall ($X_1$) in three revenue divisions as well as the district as a whole is negative and significant. The positive relationship is expected between the rainfall and the agricultural productivity. The expected and observed relationships pertaining to the rainfall variable are in opposite direction. It may be observed that the actual rainfall is not favourable to enhance the agricultural productivity. The negative and significant co-efficient expresses that the rainfall is more than sufficient in promoting the agricultural productivity in the study area. It may be concluded that the agricultural productivity may be increased by providing sufficient irrigation facilities to agriculture.

The estimated co-efficient of percentage of irrigated area ($X_2$) is positive and significant in Chittoor division as well as in Chittoor district as a whole. But in the case of remaining two divisions namely Tirupati and Madanapalle, it is negative and significant. The variable $X_2$ is having positive and significant relationship with the dependent variable ‘agricultural productivity’. It is observed that the expected and observed relationships of the irrigated area with the dependent variable ($Y$) are the same. Whereas this relationship is in opposite direction in the two divisions Tirupati and Madanapalle. But this negative relationship is significant. It shows that the percentage of irrigated area is having negative relationship with the agricultural productivity. It is also observed that the insufficient irrigation facilities will decrease the productivity in Tirupati and Madanapalle divisions. Finally, it is concluded that, by enhancing the irrigation facilities the agricultural productivity may be possible to increase.

The estimated co-efficient of average size of operational holding ($X_3$) is positive and significant in Chittoor division. But it is negative and significant in the other two divisions Tirupati and Madanapalle and the district as a whole. The expected relationship between dependent and independent variable is negative i.e., as the size of operational holding increases the agricultural productivity may be decreased. It is observed that the expected relationship is contradictory in Chittoor division only. It means the concentration of farmers on operational holding is more because of the agricultural households are comparatively more than the net sown area in Chittoor division. It is because the increase in irrigated area will increase the productivity irrespective of average size of operational holding in this division. The estimated co-efficient of land concentration ratio ($X_4$) is positive and significant in Chittoor division. But it is negative and significant in the other two divisions namely Tirupati and Madanapalle and the Chittoor district as a whole. The expected relationship between dependent variable agricultural productivity and independent variable land concentration ratio is positive i.e., the agricultural productivity increases with the increase in land concentration ratio. It is observed that the expected and observed relationships between the land concentration ratio and the dependent variable are coinciding in the Chittoor division. Whereas the relationship between $X_4$ and $Y$ is in opposite direction in Tirupati and Madanapalle divisions and in Chittoor district as a whole. Finally, it may be concluded that, by raising the land concentration ratio, it is possible to increase the agricultural productivity. Under the Indian conditions, the studies in farm management and 1961 census data
reveals the negative relationship between the land concentration ratio and the productivity. This negative relationship is also significant for combination of some rice and wheat in East India.

The estimated co-efficient of workers-area ratio ($X_5$) is negative in Chittoor, Tirupati divisions and Chittoor district as a whole. But it is not significant in Chittoor division. Whereas it is positive and significant in Madanapalle division. The labour productivity is positive in Madanapalle division due to the optimum utilization of available resources. The variable $X_5$ is having positive and significant relationship with the agricultural productivity. It is observed that the expected relationship between the $X_5$ variable and agricultural productivity is contradictory in all cases expect in Madanapalle division. The negative and insignificant co-efficient shows that, an increase in the workers-area ratio will decrease the agricultural productivity. It is also observed that the expected relationship of the $X_5$ variable with $Y$ variable is contradictory in Tirupati division as well as in Chittoor district as a whole. The negative and significant co-efficient shows that the agricultural productivity may be raised by increasing the workers-area ratio. Whereas the observed and expected relationships between $X_5$ and $Y$ are coinciding in Madanapalle division.

The estimated co-efficient of percentage of hired workers ($X_6$) is negative and significant in Chittoor division. But it is positive and significant in the other two divisions Tirupati and Madanapalle and in the Chittoor district as a whole. The expected relationship between dependent and independent variables is positive. It is observed that the observed and expected relationships between the percentage of hired workers and the agricultural productivity are coinciding in Tirupati and Madanapalle divisions and in Chittoor district as a whole. Whereas in Chittoor division the relationship between $X_6$ and $Y$ is in opposite direction. But this negative relationship is significant in Chittoor division. It shows that the percentage of hired workers is having negative relationship with the agricultural productivity. It is also observed that the low percentage of skilled hired workers will decrease the agricultural productivity in the Chittoor division. Finally, it is concluded that it is possible to increase the agricultural productivity by improving the percentage of hired workers in Chittoor division.

The estimated co-efficient of fertilizers and pesticides consumption per acre ($X_7$) is negative and significant in Chittoor division as well as in Chittoor district as a whole. In the case of the other two divisions Tirupati and Madanapalle it is positive and significant. The variable $X_7$ is having positive and significant relationship with the dependent variable agricultural productivity. It is observed that the observed and expected relationships between $X_7$ variable and the $Y$ variable are coinciding in Tirupati and Madanapalle divisions. Whereas this relationship is in opposite direction in the Chittoor division. It is observed that the less quantity of fertilizers and pesticides consumption will decrease the agricultural productivity in Chittoor division as well as district as a whole. Finally, it may be concluded that the agricultural productivity is raised by increasing the consumption of fertilizers and pesticides in the Chittoor division as well as in Chittoor district as a whole. It is also observed that the consumption of fertilizers and pesticides is comparatively less in Chittoor division than the other two divisions.

**CONCLUSIONS**

The positive and significant trend in productivity is observed in entire Chittoor district. The average annual increase in agricultural productivity is approximately 338 rupees. A linear growth rate of 9.18 percent is recorded in agricultural productivity. A variation of 99.6 percent is observed in agricultural productivity by the time factor.

In case of Chittoor revenue division, the variables – percentage of irrigated area and the land concentration ratio reveal a positive and significant effect on agricultural productivity. It is noticed that the observed relationship coincides with the expected relationship. The variable ‘workers-area ratio’ establishes an insignificant negative relationship with
agricultural productivity. A negative relationship is observed between this variable and agricultural productivity. The observed negative relationship is contradictory to the expected positive relationship. Average size of operational holding establishes positive and significant relationship with the explained variable. It is observed that there exists contradictory relationship between observed and expected relationships. It means the farmer’s concentration on operational holding is more because, the agricultural households are comparatively more than the net sown area. Hence, the increase in irrigation facilities will raise the productivity irrespective of average size of operational holding in this division. The estimated co-efficients of the variables – actual annual rainfall, percentage of hired workers and fertilizers and pesticides consumption per acre are negative and significant. It is observed that there is contradictory relationship with expected relationship. The insufficient rainfall may decrease the agricultural productivity. The productivity may be enhanced by providing additional irrigation facilities. Agricultural productivity may also be decreased due to increase in unskilled hired workers. It is also observed that, the third stage of law of variable proportions is operating in the case of input labour. It means, as the labour increases, the marginal product of labour is decreasing. This decrease in marginal product will lead to the decrease in average product. It is also found that, the consumption of chemical fertilizers is less in Chittoor division and hence the productivity may be raised by increasing the consumption of fertilizers and pesticides in this division.

In case of Tirupati revenue division, the estimated co-efficients of the variables – average size of operational holding, percentage of hired workers and fertilizers and pesticides consumption per acre reveal negative, positive and positive relationship with agricultural productivity respectively. It is observed that these observed relationships coincide with the expected relationships. The operation of these variables on agricultural productivity is not different from the hypothesis of the study. The variables – annual rainfall, irrigated area, land concentration ratio and workers-area ratio, individually, establishes the significant negative relationship with agricultural productivity. These four variables establishes contradictory relationship with the expected relationship. The significant negative co-efficient of the variable ‘rainfall’ expresses that, as the rainfall increases the agricultural productivity will decrease. This is due to excess and irregular rainfall in this division. It is also inferred that by providing sufficient irrigation facilities, the productivity may be raised. The co-efficient of the variable ‘percentage of irrigated area’ expresses that agricultural productivity may be increased by enhancing the irrigation facilities. It may also be concluded that there is some scope to raise the agricultural productivity by augmenting the irrigation facilities. In case of land concentration ratio, it is expected that higher concentration ratio leads to large sized holding. The productivity levels should be higher in large sized holdings due to the better management and usage of large amount of input materials. But it is contradictory in the present study. i.e., productivity will be decreased by increasing the land concentration ratio. Hence, it may be concluded that the agricultural productivity may be raised by decreasing the land concentration ratio. The co-efficient of workers-area ratio reveals that, there is some possibility to raise the agricultural productivity by increasing the units of the above variable. It means, the total number of workers may be raised on net sown area. The combined effect of all explanatory variables on agricultural productivity is 90.46 percent.

The results obtained in Madanapalle revenue division coincides with the results with the results obtained in Tirupati division, except for the variable ‘workers-area ratio’. The observed and expected relationships pertaining to this variable coincides with each other. It is also inferred that the productivity will be increased significantly by increasing the units of the variable ‘workers-area ratio’. All the variables considered in the model, show a variation of 45.17 percent in agricultural productivity.

In case of Chittoor district as a whole, the observed and expected relationships of the explanatory variables – percentage of irrigated area, average size of operational holding and percentage of hired workers are coinciding with the
explained variable agricultural productivity. The remaining four variables establishing the negative and significant relationship with agricultural productivity. The observed negative relationship is contradictory to the expected positive relationship. The observed relationship of annual rainfall with agricultural productivity is negative and significant. It reveals that excess and unseasonal rainfall are the causes of decrease in agricultural productivity. By providing sufficient irrigation facilities, the agricultural productivity may be increased in entire Chittoor district. With respect to the variables – land concentration ratio and workers-area ratio, the results obtained in Tirupati division are similar to that of results obtained in the district as a whole. The observed and expected relationships between agricultural productivity and consumption of fertilizers and pesticides are contradictory. It is inferred that there is possibility to raise the productivity by increasing the consumption of fertilizers and pesticides. The collective effect of all selected independent variables on agricultural productivity is 59.32 percent.

REFERENCES


