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Trends In And Determinants Of Agricultural Productivity:

(A Case Study on Ananthapuramu District, Andhra Pradesh)

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Abstract

Agriculture plays a crucial role in the process of economic development of developing countries, as a basic industry. Without achieving substantial increase in agricultural production, no country has moved to the takeoff stage of economic development. In the determination of agricultural labour wages also agricultural production has been playing a prominent role. In emphasizing the role of the agriculture in the development of Indian economy, it is observed, "if one sector limits to growth of the other, it is more likely to be a case of agricultural growth, limiting non-agricultural sector than vice-versa. Ananthapuramu district is no exemption from this. Though there were number of studies on the agricultural sector of the district, this type of studies, 'trends in and determinants of agricultural productivity' are very rare and it helps to successful implementation of several programs to improve the agricultural productivity in the district. To study the 'trends in and determinants of agricultural productivity' simple and multiple regression equations were adopted respectively. A positively significant increasing trend was found in agricultural productivity. In view of determinants of agricultural productivity, it was found that it may increase the agricultural productivity by increasing certain variables which are positively associated with agricultural productivity in the district.

Introduction

Agriculture continues to assume the role of basic industry in some degree or the other in every country as long as the former continues to feed and clothe the world. Agriculture as a basic industry plays a crucial role in the economic development of the country. But the contribution of the agricultural sector to overall economy varies from country to country depending upon the level of economic development. Economic development may be defined as 'transformation of economy which is predominantly agricultural and traditional in to one largely industrial and modern'. A historical record clearly shows that no country has moved from the chronic stagnation to the take-off stage of economic development without achieving substantial increase in agricultural production. In the early stages of economic development of modern advanced states, a high rate of agricultural production has played a crucial role in furthering overall economic growth. In the case of less developed countries, substantial progress in the most backward part of the economy was a prerequisite for a successful development of the economy as a whole.

In emphasizing the role of agriculture in development of Indian economy, it is observed, "if one sector limits growth of the other, it is more likely to be a case of agricultural growth, limiting non-agricultural sector than vice versa. Generally agricultural productivity may be defined as 'the average yield per hector of land.' After the introduction of modern agricultural technique along with the adoption of hybrid seeds, extension of irrigation facilities and application of intensive methods of cultivation in India, yield per hector of crops has recorded a steep rising trend. Agricultural productivity in India has undergone an abrupt change in the post-green revolution period. Agricultural productivity, which is composed of both productivity of land and labour as well, is among the lowest in the world despite increase in the yield. Average yield per

hector in India is quite below the world's average in all crops. It shows the backwardness of the Indian agricultural sector.

It is said to be a gamble of monsoons and other natural calamities, which affect agricultural productivity in India. The increase in production and productivity of agricultural sector are influencing the wages. The Ananthapuramu district is no exemption from this. The wage level and agricultural productivity are very low in the district as compared by other districts in the state. So, the Ananthapuramu district was selected to study the causes and circumstances, which are influencing the low agricultural productivity and to give suggestions to improve the agricultural productivity in the district.

District Profile and Need of the Study

Ananthapuramu district, being one of the 26 districts, is founded the place in the Rayalaseema region of Andhra Pradesh state. The district is formed in the year 1882 and derived its name after the head quarter town of Anantapur. In the year 2022, as part of the re-organization of the districts Sri Sathya Sai district was carved out. Presently the district exists with 3 revenue divisions, named Ananthapuramu, Guntakallu and Kalyandurgam.

The total geographical area is 10,205 square kilometers with 2, 241, 105 populations by 977 sex ratio and the literacy rate in the district is 64.28. The district is the driest of all the drought prone districts of Andhra Pradesh state. In the district, it is clearly estimated that the drought visits at least thrice in a decade. The irrigation commission and central commissions has been identified the whole district as drought-prone. Due to converting the district into desert the people, especially agricultural labour and tiny-formers were founded that their lives are 'rigorous and not bearing' and they are migrating in searching gainful employment. The groundnut occupies first place among the main crops like Paddy, Jowar, Bajra, Ragi, Groundnut and Sugarcane in the district.

Review of literature

S.P. Sharma made an attempt to study the relative association per acre productivity (20 crops) with rainfall, irrigation, holding-size, land concentration ratios, pure tenancy, workers per acre, area up to 5 acres, mixed tenancy and hired workers in crop zones, state zones and all India per the period 1989-90 to 1991-92. The study examines the relative impact of nine independent variables on per acre productivity. On this basis, it has been possible to isolate crop zones and state zones having positive or negative marginal labor productivity.

R.K.Rana's study of land productivity differentials in India, attempted to examine the inequality in land productivity among different states of India. This was based on cross-sectional data. He observed that the role of rainfall is significant due to untimely nature, inadequacy of rain. The per capita cropped area and the interest rate are also insignificant on productivity. The quality of soil shows significant effect on the land productivity. He suggested five policy measures would help to reduce the variation in land productivity among the states and also help to achieve greater optimality in resource use.

V.N. Misra and S.B.L. Gupta in their stud of Gujarat, factors affecting inter-district wage-differentials for the year 1978-79 found that, the availability of pump-sets and agricultural labor turnout to be significant and has positive sign for its co-efficient. Though the extent of irrigated area assumed positive sign, it failed to yield significant contribution to wage rates.

Objectives

The following are objectives of the present study. They are . …

1. To study trends in agricultural productivity, and
2. To study the relative association of agricultural productivity with selected independent variables (i.e., determinants of agricultural productivity) in Ananthapuramu district.

Methodology

To study the first objective, trends in agricultural productivity in the district the simple regression model was carried out.

$$Y=a+bt$$

Where,

Y=agricultural productivity

t= time in years

a and b are the constants.

To estimate the linear growth rate in agricultural productivity the below formula is adopted

$$LGR = \frac{\hat{b}}{\bar{Y}} \times 100.$$

To study the second objective, determinants of agricultural productivity the multiple regression analyses is taken out.

$$Y=f(x_1, x_2, x_3, x_4, x_5, x_6, x_7)$$

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-efficient of independent variables, a_0 is the constant.

The combined effect of independent variables on agricultural productivity is carried out by multiple correlations co-efficient and is tested for its significance by the F-test statistic and t-test statistic also calculated for significance of each independent variable on productivity.

The specifications of the variables are given below.

Agricultural productivity (Y): Initially six major crops were selected, namely, 1) Paddy, 2) Jowar, 3) Bajra, 4) Ragi, 5) Groundnut and 6) Sugarcane. The production of each crop in each mandal is collected the crop production was multiplied by average price of the particular crop. The average productivity of the crop in each mandal is computed with the help of

$$Y = \frac{\sum_{i=1}^{6} \text{total agricultural production of each crop x average price}}{\sum_{i=1}^{6} \text{total Area under the crops}}$$

X_1- Agricultural annual rainfall (in mms): Generally the positive relation is expected between Y variable and x_1 variable.

X_2-Percentage of irrigated area: There is a positive relation between x_2 and Y variables. The formula is

$$x_2 = \frac{\text{Gross area irrigated}}{\text{Gross area shown}}$$

X_3-Average size of operational holdings: It is expected that there is negative relation between Y and x_3 variables.

$$x_3 = \frac{\text{Net area shown}}{\text{No. of agricultural}}$$

X_4-Land concentration ratio: Theoretically positive relation is expected between x_4 and Y variables.

$$x_4 = \frac{\text{Net area shown}}{\text{Total population}}$$

X_5-Workers-area ratio: It is assumed that there is a positive relation between x_5 and Y variables

$$x_5 = \frac{\text{Total workers}}{\text{Net area shown}}$$

X_6-Percentage of Hired workers: A positive relation is expected between the x_6 and Y variables.

$$x_6 = \frac{\text{Hired workers}}{\text{Total agricultural workers}} \times 100$$

X_7-Fertilizers and Pesticides consumption per Acre: Generally there is a positive relation is expected between x_7 and Y variables.

$$x_7 = \frac{\text{Total consumption of fertilizers and pesticides}}{\text{Gross area shown}}$$

Here, Y variable is dependent and x_1 to x_7 variables are independent variables.

To test the significance of each independent variable, t-test statistic is adopted.

$$t = \frac{\hat{a}_i}{S.E(\hat{a}_i)} \rightsquigarrow t(n-k)$$

Where,

n= number of observations
k = number of variables
i = refers to the variable

The combined effect of all independent variables on dependent variable calculated by multiple regression coefficient ($R^{2)}$.

$$R^2 = 1 - \frac{\varepsilon ei^2}{\varepsilon y_i^2}$$

For the significance of R^2, F-test statistic is carried out.

$$F = \frac{R^2 (k-1)}{(1-R)/(n-k)}$$

Where,

R^2= multiple correlation co-efficient
k= total number of variables
n= total number of observations.

Data: The present study is depended on both primary and secondary data. The primary data is collected by field survey - 2021-23. The secondary data is gathered from 'Hand Book of Statistics' issued by chief planning officer, Ananthapuramu, and unpublished records of the same office.

Analysis:

Trends in agricultural productivity

Generally in agricultural sector, productivity is called as 'total output divided by the land units.' This is also known as average yield per unit of land. In the present study trends in agricultural productivity is calculated by simple regression analysis considering the time factor (years) as independent variable and productivity (rupees) as dependent variable.

The estimated linear equation of agricultural productivity in Ananthapuramu district is

$$Y= 421.37+432.6^{*}t$$

(18.87)

r = 0.8652 LGR=9.22

From the above equation, the co-efficient of't' i.e., the value of b is 432.6.It is positive and significant. There is an increasing trend in agricultural productivity in Ananthapuramu district. It means on average of 462.6 rupees of agricultural productivity increasing every year during the study period. But this increment is significant. The effect of time on agricultural productivity is 0.8652. It shows that 86.52 percent of variation is observed by the time factor. The linear growth rate is 9.18 percent and shows average annual increase in agricultural productivity. The value of intercept term is 421.37.

Determinants of Agricultural Productivity

Generally agricultural productivity affected by various factors; in the present study, some important variables are taken into consideration. They are annual rainfall, percentage of irrigated area, average size of operational holdings, land concentration ratio, workers- area ratio, percentage of hired workers and fertilizers and pesticides consumption per acre.

Type of the Variable and expected Relation

Variable	Description of Variables	Type of Variables	Expected relationship with agricultural productivity
Y	Agricultural productivity.	Explained	-
X_1	Agricultural annual rainfall	Explanatory	Positive
X_2	Percentage of irrigated area	"	Positive
X_3	Average size of operational holdings	"	Negative
X_4	Land concentration ratio	"	Positive

X_5	Workers- area ratio	"	Positive
X_6	Percentage of hired workers	"	Positive
X_7	Fertilizers and pesticides consumption per acre	"	Positive

To calculate the combined effect of all explanatory variables on explained variables the regression equation for each division of the district taken and analyzed accordingly.

Ananthapuramu division

The estimated regression equation for the division is

$$Y=192.4515 - 1.2741^{*}x_1 + 15.9234^{*}x_2 + 1577.6547^{*}x_3 + 249.1199^{*}x_4 - 57.0737x_5 - 99.5297^{*}x_6 - 7.3059^{*}x_7$$
$$(0.1078) \quad (1.4467) \quad (78.7934) \quad (17.2032) \quad (74.4144) \quad (2.1837) \quad (0.1058)$$

$R^2 = 0.3814$ $F=3.4300^{*}$

* Significant at 5 percent probabilities level. Figures in the parentheses are the standard errors of the estimates.

The estimated co-efficient of the variables annual rainfall (x_1), 'percentage of hired workers (x_6) and fertilizers and pesticides consumption per acre' (x_7) are having positive and significant association with agricultural productivity (y). It reveals that an increase in x_1, x_6 and x_7 variables will increase agricultural productivity significantly. The co-efficient of the variable workers area ratio' (x_5) having negative and in significant association with the dependent variable, 'agricultural productivity' (y). It reveals that an increase in x_5 variable will reduce the agricultural productivity in significantly. Similarly, the co-efficient of the variables 'percentage of irrigated area' (x_2), average size of operational holding (x_3) and 'land concentration ratio' (x_4) are having positively significant relation with agricultural productivity. It reveals that an increase in x_2, x_3 and x_4 variables will increase the agricultural productivity significantly.

The multiple correlations co-efficient (R^2) is the collective effect of all independent variables on dependent variable. The value of R^2 is 0.3814. It means, 38.14 percent of variation is observed in agricultural productivity. From F test statistic this percentage of variation is 3.43 and is significant.

Guntakallu division

The estimated regression equation for the Guntakallu division is

$$Y=202.4936 - 7.3851^{*}x_1 - 51.7501^{*}x_2 - 1062.2149^{*}x_3 - 778.1399^{*}x_4 - 1353.0625^{*}x_5 + 71.4346^{*}x_6 + 6.4509^{*}x_7$$
$$(0.0294) \quad (0.7167) \quad (39.7585) \quad (11.7702) \quad (18.0569) \quad (1.0177) \quad (0.4989)$$

$R^2=0.9046$ $F=4.5040^{*}$

The estimated co-efficient of the variables, 'actual annual rainfall' (x_1), 'percentage of irrigated area' (x_2), 'average size of operational holding' (x_3), 'land concentration ratio' (x_4) and workers area ratio' (x_5) are having negatively significant association with 'agricultural productivity' (y) significantly. Similarly, the co-efficient of the variables, 'percentage of hired workers (x_6) and 'consumption of fertilizers ands pesticides per acre' (x_7) are having positively significant association with 'agricultural productivity' (y). It reveals that an increase in x_6 and x_7 variables will increase the Y variable significantly.

The value multiple correlation (R^2) is 0.9046, means 90.46 percent of variation is observed in agricultural productivity. F-value is 4.5040 and is significant.

Kalyandurgam division

The estimated regression equation for Kalyandurgam division is

$$Y=93.6903 - 0.4247^{*}x_1 - 40.3496^{*}x_2 - 1337.4312^{*}x_3$$
$$(0.0217) \quad (0.4532) \quad (8.0739)$$

$$- 909.7139^{*}x_4 + 47.8601^{*}x_5 + 77.0246^{*}x_6 + 9.6504^{*}x_7$$
$$(9.2226) \quad (22.4053) \quad (0.6609) \quad (0.1562)$$

$R^2=0.4517$ $F=1.1876^{*}$

The co-efficient of the variables, 'actual annual rainfall' (x_1), 'percentage of irrigated area' (x_2), 'average size of operational holdings' (x_3) and land concentration ratio' (x_4) are having negatively significant relation with 'agricultural productivity' (Y). It reveals that an increase in x_1, x_2, x_3 and x_4 variables will decrease the 'agricultural productivity' (Y) significantly. Similarly, the co-efficient of the variables, 'workers-area ratio' (x_5), 'percentage of hired workers' (x_6) and 'consumption of fertilizers and pesticides per acre' (x_7) are having positively significant association with 'agricultural productivity' (Y). It reveals that an increase in x_5, x_6 and x_7 variables will increase the 'agricultural productivity (Y) significantly.

The value of multiple correlations (R^2) is 0.4517, means 45.57 percent of variation is observed in 'agricultural productivity' (Y). This value is insignificant by F-test i.e., 1.1876.

Ananthapuramu district as a whole

The estimated regression equation for the entire district is

$$Y=2143.9614 -7.5046^{*}x_1 - 11.3370^{*}x_2 - 1124.4717^{*}x_3$$
$$(0.0183) \quad (0.3369) \quad (8.6856)$$
$$- 351.5408^{*}x_4 - 2544.3893^{*}x_5 - 93.4706^{*}x_6 -5.5959^{*}x_7$$
$$(4.0161) \quad (14.6257) \quad (0.6409) \quad (0.0547)$$

$R^2=0.5932$ $F=4.4980^{*}$

The co-efficient of the variables, 'actual annual rainfall' (x_1), 'average size of operational holdings' (x_3), 'land concentration ratio' (x_4), 'workers-area ratio' (x_5) and 'consumption of fertilizers and pesticides per acre' (x_7) are having negatively significant association with 'agricultural productivity' (Y). It reveals that an increase in x_1, x_3, x_4, x_5 and x_7 variables will decrease the 'agricultural productivity' (Y) significantly. Similarly, the co-efficient of the variables 'the percentage workers' (x_6) are having positively significant association with 'agricultural productivity' (Y). It reveals that an increase in x_2 and x_6 variables will increase the 'agricultural productivity' (Y) significantly.

The value of multiple correlations co-efficient (R^2) is 0.5932. It means 59.32 percent of variation is observed in agricultural productivity. From F-test, R^2 value is 4.4980 and is significant.

Inter-divisional comparison

The estimated co-efficient of 'actual annual rainfall' (x_1) is negative and significance in all the three division and in the district as a whole. It reveals that the observed relation between x_1 and Y variables is negative and is opposite direction to expected relationship. So, there is no scope to raise the agricultural productivity by raising the x_1 variable. The co-efficient of the 'percentage of irrigated area' (x_2) is positive and significant in Ananthapuramu division and in entire the district as a whole. It reveals that an increase in x_2 variable will increase in agricultural productivity significantly. But the x_2 variable is having negative and significant relation with 'agricultural productivity' (Y). It shows that an increase in x_2 variable will decrease the agricultural productivity significantly. The co-efficient of 'average size of operational holdings' (x_3) is having positive and significant relation with 'agricultural productivity' (Y) in Ananthapuramu division only. It reveals that an increase in x_3 variable will increase in agricultural productivity significantly in the division. But in Guntakallu and Kalyandurgam divisions as well as in the entire district, the co-efficient of the x_3 variable is having negatively significant relation with 'agricultural productivity' (Y). It reveals that the increase in x_3 variable will decrease the agricultural productivity significantly.

The co-efficient of 'land concentration ratio' (x_4) is having positively association with 'agricultural productivity' (Y) in only Ananthapuramu division. It reveals that an increase in x_4 variable will cause to decrease in 'agricultural productivity' significantly. Similarly, the co-efficient of 'land concentration ratio' (x_4) is having negatively association with 'agricultural productivity' in Guntakallu and Kalyandurgam divisions, as well as in the district as a whole. It reveals that an increase in x_4 variable will decrease the 'agricultural productivity' (Y) significantly. The co-efficient of 'workers-area ratio' (x_5) is having negatively insignificant association with the 'agricultural productivity' (Y). It reveals that an increase in x_5 variable will decrease the 'agricultural productivity' (Y) insignificantly. So, there is some scope to raise the

x_5 variable to raise the 'agricultural productivity' (Y). But in Guntakallu and Kalyandurgam divisions as well as in the entire district as a whole the 'co-efficient of workers-area ratio' (x_5) is having negatively significant association with 'agricultural productivity' (Y). It reveals that there is no scope to raise the 'Y' variable by raising the x_5 variable.

The co-efficient of the percentage of hired workers' (x_6) is having negatively significant association with 'agricultural productivity' (Y) in Ananthapuramu division only. But in Guntakallu and Kalyandurgam as well as district as a whole x_6 variable is having positively significant association with 'agricultural productivity' (Y). The negatively significant association in Ananthapuramu division reveals that there is no scope to increase the Y variable by increasing x_6 variable. Contradictorily, in remaining divisions and entire district there is a large scope to raise significantly the 'agricultural productivity' (Y) by raising the 'percentage of hired workers'. The co-efficient of 'consumption fertilizers and pesticides per acre' (x_7) is having positively significant association with 'agricultural productivity' (Y) in Guntakallu and Kalyandurgam divisions. This positively significant association reveals that an increase in x_7 variable i.e., 'consumption of fertilizers and pesticides per acre' will increase the 'agricultural productivity.' (Y) Significantly, but in Ananthapuramu division and entire the district as a whole, it is in opposite direction, means having negatively significant association with 'agricultural productivity' (Y). It reveals that an increase in x_7 variable will cause to decrease in 'agricultural productivity' (Y).

Summary and suggestions

Agricultural productivity is the average yield per one unit of input land. Productivity of all crops recorded a step rising trend after the Green Revolution. Trends in and determinants of agricultural productivity are studies in the present study. The summary and suggestions are given with succeeding paragraphs. A positive and significant trend is observed in agricultural productivity in entire Ananthapuramu district. The average annual increase in agricultural productivity is approximately 338 rupees. In agricultural productivity a linear growth rate of 9.18 percent is recorded in agricultural productivity by the time factor n the study period.

In the view of determinants of agricultural productivity, in the case of Ananthapuramu division the variables, 'actual annual rainfall', 'percentage of hired workers' 'workers-area ratio and consumption of fertilizers and pesticides per acre' are due to having negatively significant association there is no scope to raise the agricultural productivity by raising above said variables except the variable 'workers-area ratio' due to having negatively insignificant association. This negative and insignificant association reveals that an increase in x_5 variable will decrease the agricultural productivity insignificantly. But there is some scope to increase the 'agricultural productivity by increasing the variables 'percentage of irrigated area', average size of operational holdings' and land concentration ratio in the Ananthapuramu division. So, it is suggested that there is no scope to increase the agricultural productivity by increasing x_1, x_5, x_6 and x_7 variables. But there must increase the agricultural productivity by increasing the x_2, x_3 and x_4 variables in the division.

In Guntakallu division there is no scope to raise the agricultural productivity by raising all variables except x_6 and x_7 variables because of having negatively significant relation with agricultural productivity. But there is a large scope to raise the agricultural productivity by rising x_6 and x_7 variables alone to having positively significant association. So, it is suggested to improve the agricultural productivity, the consumption of fertilizers and pesticides per acre are cause to improve the agricultural productivity in the division.

In Kalyandurgam division, the variables, 'actual annual rainfall', 'percentage of irrigated area' 'average size of operational holding and land concentration ratio are due to having negatively significant association with agricultural productivity there is no scope to rise the agricultural productivity by increasing above said independent variables. But it is possible to raise the agricultural productivity by rising the variables, workers-area ratio', 'and percentage of hired workers' and 'consumption of fertilizers and pesticides per acre' due to having positively significant association. So, it is suggested to improve the agricultural productivity by increasing x_5, x_6 and x_7 variables. In the district as a whole there is no scope to raise the 'agricultural productivity' by raising the 'actual annual rainfall', 'average size of operational holdings', 'land concentration ratio', 'workers-area ratio', and consumption of fertilizers and pesticides per acre' due to having negatively significant association with agricultural productivity in the district. But it is possible to raise the 'agricultural productivity' significantly by raising the variables, 'percentage of irrigated area' and 'percentage of hired workers' due to having positively significant association with 'agricultural productivity'.

It may comes to conclusion by giving suggestions briefly that in Ananthapuramu division it is possible to increase the agricultural productivity by increasing only 'percentage of irrigated area', 'average size of operational holdings'. Similarly, in Guntakallu division it is possible to increase the agricultural productivity significantly only by increasing 'workers-area ratio', percentage of hired workers' and consumption of fertilizers and pesticides per acre'. In Kalyandurgam division, it is possible to increase the agricultural productivity significantly only by increasing the 'workers-area ratio', percentage of hired workers' and 'consumption of fertilizers and pesticides per acre' in the division.

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