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RESEARCH ARTICLE

AN ANALYSIS ON TREND AND DETERMINING FACTORS OF AGRICULTURAL PRODUCTIVITY: A CASE STUDY OF HOOGHLY DISTRICT (WEST BENGAL)

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ABSTRACT

Agricultural productivity can be measured in terms of the final products produced and the inputs requirement for the output. Although a considerable number of research works has been carried out on agricultural productivity in Hooghly district, but the study on the trends and the determinant factors of the agricultural productivity is rare. Therefore, scientific, empirical, factor-intentive investigation is an essential phenomenon in the rural economy of Hooghly district. This piece of work has an intention to find out the actual trends followed in the agricultural productivity in this district. Another aim is to identify and examine the scientific factors which determine the agricultural productivity in this particular place. To calculate the productivity trends, we consider the periods 1989-90 to 2009-2010 by taking Triennium period (the average of the three-years productivity). Our observations are based on primary data of 200 samples. To determine the impact of some relevant factors on agricultural productivity, we use multiple regression model. For calculating agricultural productivity simple regression analysis has been applied in this study. This work reveals that there is an increasing trend in agricultural productivity in Hooghly district during the period of study. Agricultural productivity in our survey area has shown a rising trend due to positive effect of irrigation facilities, average size of operational holdings, further scope of utilization of fertilizers and high yielding variety of seeds.

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INTRODUCTION

Agriculture is the backbone of Indian economy. It plays many significant roles like major source of food to population and employment opportunities by providing raw materials for the industries. By 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/acre of land. Due to its importance, the government of India gives high priority to agricultural sector by setting a strategy of agriculture development programmes. The main goal of the agricultural policy is not only achieving the sustainable increase in agricultural production and productivity of small holder farmers but also accelerate agricultural commercialization and agro-industrial development in the country. Agricultural productivity can be increased by using two alternative methods. The first way is through improvement in technology given some level of input and the other option of improving productivity is to enhance the output per household labour-ratio of rural household farmers, given fixed level of inputs and technology. As per as the first strategy of development is concerned, the introduction of modern agricultural techniques along with the adoption high-yielding variety of seeds, extension of irrigation facilities, application of chemical fertilizers and pesticides in the cultivation of India, yield per acre of all crops has recorded a steep rising trend. A dramatic change in the agricultural productivity has been taken place in post green revolution period. But the success of green revolution was limited into some particular states only, like Punjab, Haryana and Western Uttar Pradesh. But the agricultural productivity in all other parts of India remain more or less static or increased slowly and the agricultural productivity of some crops (e.g. wheat, paddy) in those particular states adopting new technology has increased substantially. All these things had led to a high degree of inter-state differences/disparities in agricultural productivity in the country. Average yield per hectare in India is quite below as compare with the world average in all crops. Agricultural productivity which is composed productivity land and the labour as well, is lowest in the world. In spite of the introduction of economic planning in India, some steps have

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been undertaken for improving the conditions of agriculture, but yet the situation is more or less the same. Hence, it is quite essential to analyse the various factors which are responsible for the backwardness of Indian agriculture. Another important fact that in India, food demand will increase just double by 2050 due to high growth rate of population and it may increase the competition for resources such as land, water, capital, labour and other precious natural resources. India has a 17.5% of global population but 2.1% of world's arable land (census, government of India, 2011). Therefore, in India food security is major concern in many perspectives like increasing demand of food for growing population, poverty, declining arable land due to higher industrialisation and urbanization, and declining agricultural productivity due to climatic change or other reason.

In India, our dependency on agriculture, different socio-economic phenomena like farmers' conservative outlook, illiteracy, ignorance, superstitions etc. are the obstacles to adopt the new technology in agriculture. Nature still dominates agriculture in India. It is said to be a gamble of monsoons. The insufficient financial assistance is the other main cause of agricultural backwardness. Apart from these, some institutional factors also go against the Indian farmers in stepping up their agricultural productivity. A considerable number of studies/research works have been conducted in this context in West Bengal. But the research on the trend and the determining factors of agricultural productivity is still not sufficient in the rural economy of Hooghly. Therefore, a scientific, empirical, factor-intentive investigative study on agricultural productivity in Hooghly district is an essential requirement. In this piece of work, we have an intention to find out the trends of agricultural productivity as well as the determinants of it in Hooghly district, West Bengal. Our work consists of six sections. In the 2nd section we write our objectives, followed by the 3rd section covers the review of literature, the 4th section explains the methodology, the section 5 gives the results, analysis and findings and section 6 ends with the conclusion.

Objectives

In this research work, our two fold objectives are as follows:--

(i) To determine the trend in agricultural productivity in Hooghly district, West Bengal during the period 1989-90 to 2009-2010.
(ii) To identify and examine the determining factors which are actually responsible for the agricultural productivity in our survey area.

Keeping in view of our motivation of work, we would like to formulate the hypothesis as follows:

(i) The trend of agricultural productivity shows a rising tendency during the relevant periods in Hooghly, and
(ii) İrrigation facilities, high-yield variety of seeds, utilization of chemical fertilizers, pesticides can be considered as the determining factors of agricultural productivity in our study area.

Review of Literature

There exists quite vast literature on the trends of agricultural productivity, determinants of it and the way outs to improve the agricultural productivity in both developed and developing countries. Ellise (1993) agreed that small farms in terms of land-size are more productive than large farms and his recommendation is that agricultural development based on the promotion of small rather than the large farms can serve both growth and income distribution objectives. In Asia, Chang *et al*. (2001) determined how to promote agricultural productivity growth to achieve sustainable food security. The study looked at the role of investment, both in physical and human capital, in maintaining and increasing agricultural productivity. They found that the only way to promote agricultural productivity was through improving labour productivity. Due to the improvement of labour productivity, the agricultural output growth for these countries has remain positive from the period 1961 to 1994. According to Hazi (2003), increased productivity in agriculture has number of advantages such as raise of flow of resources and thereby enhancing economic growth, lowers the food prices that increase consumers' welfare, improves the competitive position of the agricultural sector of a nation. Zepeda (2001) used a number of models of production growth to measure the change in output to identify the relative contribution of different inputs to output growth. He found that a relatively weak relationship between physical capital and growth, as compared to investment in technology and human capital. Fulginity *et al*. (1998) examined the changes in the agricultural productivity during the period 1961-1985 by using the data of eighteen developing countries. Their study showed the declining tendency of agricultural productivity due to use of low inputs. Econometric analysis indicated the most output growth was imputed to commercial inputs like machinery and fertilizers. Another study made by Byerlee *et al*. (2005) argued that interaction of productivity growth, farm income, employment, food prices could lead to a pro-poor outcome depending on two key situations-- agricultural productivity per land must increase at a faster rate than that of labour in order to raise employment and rural wages and total factor productivity (TFP) must increase faster than food price decrease for farm profitability to rise and for poor customers to benefit from lower food prices. Tripathi *et al*. (2008) highlighted in their work, the Indian agricultural productivity growth by using Cobb-Douglas production function. Agreed that an improvement is not only labour but also capital and land productivity can improve agricultural productivity. Their study depicts that labour and land inputs had positive and significant influence on Indian agricultural growth. Rao and Choligeat (1981) studied the relationship between the size of land holdings and agricultural productivity. They estimated a functional relation between output and inputs. Their study was conducted by using farm-level data from several states in South India overs the period 1962 to 1970. Their study found that no systematic relationship between measures of productivity and land-size. They also indicated that capital has a positive effect but land and labour, a negative effect on the elasticity of gross output per unit of land. However, large capital infusion cancelled out the negative effects of land labour and led to a positive relation between land size and productivity. Chattopadhyay (2005) highlighted the distributive impact of agricultural growth in rural West Bengal. In his study, it was revealed that during 1983 to 1993-1994, when agricultural output in West Bengal was growing at an

unprecedented rate, the degree of inequality in the distribution of rural expenditure declined significantly. However, during the later part of the 1990s, when the rate of growth of agricultural output declined substantially, its impact on rural income distribution was reversed, with the declination of rate of growth of rural employment and average earning at the agricultural labour households. Reddy (2013) presented in his paper the trends and determinants of agricultural productivity by making inter-divisional analysis in Chittoor district, Andhra Pradesh. He found that the percentage of irrigated area, average size of operation holding and percentage of hired workers have positive effect on the agricultural productivity. He observed that there is an increasing trend in agricultural productivity in Chittoor district, Andhra Pradesh.

Methodology

In our work we propose to study the trend in agricultural productivity and also identify, examine the important factors determining the agricultural productivity in Hooghly district, West Bengal. The productivity trend is calculated for the period 1979-1980 and 2009-2010. Our observation is based on the primary data collected from 200 farmers in 6 different villages of our survey area through field survey 2010-2011. The data is collected for crop-wise agricultural productivity. We consider six major crops produced in this district e.g. paddy, potato, jute, oil seeds, groundnut, green chilli. The average yield of these six crops in terms of Rupees, is considered as the agricultural productivity. To avoid the risk in productivity, observations are considered as the average of three years productivity (Triennium period).

To find out the trend, we use the following function:

$$\mathbf{Y = a + bt,} \quad \text{.....(1)}$$

where, Y: agricultural productivity (dependent variable)

a, b: are constants,
a: intercept parameter
b: co-efficient parameter/slope of the regression line.

To determine the factors affecting the agricultural productivity, multiple regression analysis is applied. Among the factors, we consider the seven major variables affecting the agricultural productivity and they are as follows: (i) annual rainfall, (ii) irrigation facilities, (iii) average size of land (iv) impact of work force associated with cultivation, (v) strength of workers, (vi) hired workers and (vii) consumption of fertilizers and pesticides per acre reflect the fertility of soil.

To analyse the relative impact of the selected inputs on our dependent variable i.e. agricultural productivity, we apply multiple regression analysis.

The relevant regression equation can be written as---

$$\mathbf{Y = f(x_1, x_2, x_3, x_4, x_5, x_6, x_7)} \text{.....(2)}$$

More specifically,

$$\mathbf{Y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + a_6x_6 + a_7x_7} \text{ ..... (3)},$$

Where

a_i (i = 1, 2, .. 7) are the coefficient of the dependent variables and a_0 is the constant or intercept term. The T-test statistic is calculated for significant effect of each independent variable on productivity. The overall effect of independent variables on agricultural productivity is calculated by multiple regression co-efficient and its significance is tested by F-test.

The specifications of our analytical variables are as follows:

Agricultural Productivity: (Our explained variable) the crop production of each category multiplied by its price per acre is treated as agricultural productivity and it is computed as –

$Y = \frac{\sum_{i=1}^{6} Q_i P_i}{\sum_{i=1}^{6} A_i}$, where, Q_i: the total agricultural product of ith crop,
A_i: the average price of the ith crop.

Actual Annual Rainfall (in mm.) (X_1)

Generally, it is supposed that the productivity rises with the increase in rainfall. So we have expected positive relation between these two variables.

Percentage of Irrigated Area (X_2)

Generally, if this variable increases, productivity increases. So there is a positive relation between them.

$$X_2 = \frac{gross\ area\ irrigated}{gross\ area\ cultivated} \times 100.$$

Average Size of Operational-holding (X_3)

In general, it is expected that there is an inverse relationship between size of the operational holding and agricultural productivity. As the size of land holding rises, it leads to a fall in the productivity.

$$X_3 = \frac{net\ area\ cultivated}{number\ of\ agricultural\ households}.$$

Land Concentration Ratio (X_4)

The land concentration ratio can be represented as the ratio of net area cultivated and the total population. Theoretically, it is assumed that this variable has a positive association with the agricultural productivity. This is because higher the concentration ratio, higher will be the area concentrated in large size of holdings as higher material inputs and better management of large sized holdings lead to higher productivity levels.

$$X_4 = \frac{net\ area\ cultivated}{total\ population}.$$

Workers-area Ratio (X_5)

The ratio between the total workers engaged in cultivation and the net area cultivated gives us the variable. It is expected that as the number of workers increase, the productivity increases.

So we may have a positive relation between these two variables.

$$X_5 = \frac{total\ workers}{net\ area\ cultivated}.$$

Percentage of hired workers (X_6)

It can be defined as the ration of hired workers to the total workers in agricultural sector, multiplied by 100. A positive relation between this variable with our productivity is to be expected, since hired workers are skilled labourers.

$$X_6 = \frac{hired\ workers}{total\ agricultural\ workers} \times 100.$$

Fertilizers and Pesticides Consumption Per Acre (X_7)

$$X_7 = \frac{total\ consumption\ of\ fertilizeres\ and\ pesticides}{gross\ area\ cultivated}.$$

In the present study, for the required secondary data we take the help of census of India, Population Census, also handbook of statistics and other official records (unpublished) of the chief planning commission.

RESULTS, ANALYSİS AND FİNDİNGS

The agricultural productivity is also known as average output per unit of land. Usually agricultural productivity gives us the relation between output produced and input requirement. In agricultural sector we express this relationship between output produced and land used. To find out the trend in agricultural productivity we take the help of simple regression analysis considering the time factors (in years) as independent variable and productivity (in Rupees) as dependent variable.

Trend in agricultural productivity

The estimated linear equation of agricultural productivity in Hooghly district can be written as follows;

$Y = 504.62 + 467.8^{*}t$, ……..(4)

(20.876) (standard error)

r = 0.9572; LGR = 8.79

'*' indicates significant at 5% critical level.

From the above equation (4) the coefficient of time (t) i.e. the value of 'b' is 467.8. It means that there is an increasing trend in the agricultural productivity in Hooghly district in West Bengal. It reveals the fact that an average of Rs. 467.8 of agricultural productivity is rising over a year during our study period. But it is significant at 5% critical level. The effect of time on agricultural productivity is shown by the value of 'r' i.e. correlation coefficient of our regression model. In our exercise, value of 'r' is 0.9572. It supports that almost 95% of variation of the agricultural productivity during our analysed period can be explained by the time factor. The Linear Growth Rate (LGR) is 8.79%. It indicates that the annual increase in agricultural productivity in Hooghly district during this period is 8.79%. The value of intercept term of our regression line is 504.62.

Determining Factors of Agricultural Productivity

The determinants of agricultural productivity in our present study are – Annual rainfall (in mm), percentage of irrigated area, average size of operational holding, land concentration ratio, workers area ratio, percentage of hired workers and fertilizers and pesticides consumption per acre. To find out the determinants and their significant of agricultural productivity multiple regression model is applied.

Table 1 shows the results of productivity function in multiple regression model:

Table 1. Results of productivity function in multiple regression model

Variables	Types of variables	Coefficients	Standard error
Constant		196.515	
X_1(actual annual rainfall in mm)	Explanatory	-1.372	0.1078*
X_2(% of irrigated area)	Explanatory	14.219	1.4361*
X_3(average size of operational holding)	Explanatory	1416.913	75.3481*
X_4(land concentration ratio)	Explanatory	211.963	16.2304*
X_5(workers area ratio)	Explanatory	-55.307	71.3261
X_6(% of hired workers)	Explanatory	-92.253	2.8126*
X_7(fertilizers and pesticides consumption per unit)	Explanatory	-8.039	0.1085*

$R^2 = 0.4183$; $F = 3.35^{*}$, '*' represents significant at 5% critical level.

Therefore the estimated regression equation of agricultural productivity during this period in Hooghly district of West Bengal is given by—

$Y = 196.515 - 1.372^{*}X_1 + 14.219^{*}X_2 + 1416.913^{*}X_3 + 211.963^{*}X_4 -- 55.307^{*}X_5 - 92.253^{*}X_6 - 8.039^{*}X_7$.

Econometric analysis of our estimated results

The estimated regression coefficient (b_1) of annual rainfall (X_1) is negative and significant at 5% critical level by using t-test statistic. This phenomenon can be interpreted in this way that an increase in one unit of rainfall will cause a 1.37% decrease in agricultural productivity. This decrease is significant. It also supports the evidence of some scope to raise the productivity by improving irrigation facilities. The estimated coefficient (b_2) of percentage of irrigated area (X_2) is positive and also significant at 5% critical level. It reveals that an increase in one unit of percentage of irrigated area will result in an increase of 14.21 units in agricultural productivity in our survey area. Another estimated coefficient in our exercise (b_3) is of the explanatory variable say average size of operational holding. It is positive and significant at 5% level. It indicates that if the average size of land is raised by one unit, the agricultural productivity will increase by 1416.91 units. It also exhibits the small size of land in Hooghly. By consolidation of holdings,

choice of appropriate farm organization, productivity can be improved. It also means larger the farm size farmers could apply more investment and better management policy. All these factors will lead to an increase in the productivity when farm-size increased. The coefficient (b_4) of land concentration ratio (X_4) is positive and significant at 5% if there is an increase in this ratio by one unit, the agricultural productivity will increase by 211.69 units. The regression coefficient (b_5) of workers area ratio (X_5) is negative and insignificant. It reveals that an increase in one unit of workers ratio will a cause of decrease the agricultural productivity by 53.30 units. This decrease is not significant. This result supports the existence of 'disguished unemployment' in our survey area which have not only zero but negative marginal productivity. That is why by increasing additional workers, agricultural productivity goes down. The coefficient (b_6) of percentage of hired workers (X_6) is negative and significant. It means that an increase in one unit of X_6, there is a reduction of productivity by 92.25 units. The negative and significant coefficient supports the fact that there is some scopes to raise the agricultural productivity by increasing the percentage of hired workers if they are properly skilled and trained. It also reveals that the numbers of skilled hired labourers are not adequate in Hooghly district. The regression coefficient (b_7) of fertilizers and pesticides consumptions acre (x_7) is negative and significant. It means that by raising one unit of X_7 the agricultural productivity will decrease by 8.03 units. This decrease is significant. The negative and significant coefficient reveals that agricultural productivity can be raised by increasing the utilization of fertilizers and pesticides in our survey area. It means that there is a scope for further improvement of productivity by raising the consumption of fertilizers and pesticides. It also supports the phenomena of appropriate application of quantity and dose of chemical fertilizers and pesticides by the farmers. This result also depicts that fact of insufficient and inappropriate utilization of fertilizers and pesticides in Hooghly district.

Conclusion

The positive and significant trend in agricultural productivity is observed in our study area, Hooghly (West Bengal). The average annual increase in agricultural productivity is approximately Rs. 468 during the period of 1989-90 to 2009-10. A linear growth rate is found about 8.79%. Almost 95% variation of the agricultural productivity can be explained by the time factor. This positive trend in this agricultural productivity is noticed due to the measures of land reforms taken by the government like consolidation of holding, ceiling of maximum land holdings, 'operation barga' i.e. given the right of the ownership of land tenure to the tenants, financial assistance provided by the banks, co-operatives, emergence of co-operative farmings etc. In Hooghly district of West Bengal, some of the factors determined the agricultural productivity like percentage of irrigated land area and land concentration ratio. These two determinant variables show positive and significant influence on agricultural productivity. The variable 'workers area ratio' establishes an insignificant relationship with agricultural productivity. This fact reveals that excessive dependency on agriculture of rural community and proves the evidence of 'disguished employment'. This phenomenon also supports the fact that lack of availability of alternative job opportunities in Hooghly district. Average size of operational holding maintenances a positive and significant relationship with our explained variable. This result is quite contradictory to our usual concept that lower the farm-size, higher will be the productivity. It means the farmer's concentration on operational holding is more because the agricultural households are comparatively more than the net cultivated area. Hence the increase in the irrigation facility will raise the productivity irrespective of the farm-size. Moreover, farmers are able to concentrate more investment and management strategies in case of large operational holding. The estimated coefficients of variables – actual annual rainfall, percentage of hired workers and consumption of fertilizers and pesticides per unit are negative and significant with our regressand. This estimated results are not coincide with our general expectations. The insufficient rainfall may decrease the agricultural productivity. The productivity may be enhanced by providing additional irrigation facilities. Agricultural productivity may decrease due to uses of unskilled hired workers. It is also evident the fact that 'law of diminishing marginal productivity' that is the third stage of 'law of variable proportions' is operating in case of labour input, when the application of other inputs remain more or less unaltered. It implies as labour increases, marginal product of labour decreases. This decrease of marginal product will lead to the decreasing average product. It is also observed that the consumption of chemical fertilizers and pesticides is lower in Hooghly. Hence the agricultural productivity may be raised by increasing the appropriate utilization of chemical fertilizers and pesticides in our study area. Finally, we may conclude in this way that although the trend of agricultural productivity in Hooghly is quite satisfactory during the period of 1989-90 to 2009-10, there is also have some scopes of further improvement by putting more attention on providing irrigation facilities, financial support, proper application of chemical fertilizer and pesticides and last but not the least proper training to the farmers.

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