

Assessing the Fertilizer Efficiency in Paddy Production

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ABSTRACT

The injudicious use of chemical fertilizers in field crops has posed a great amount of threat to the environment, besides lowering the profit from agriculture. There is a need to assess the fertilizer efficiency in specific crops to optimize their use for greater profitability and achieving sustainability. Therefore, the present study was conducted to analyze the trend and pattern of chemical fertilizer consumption in production of paddy crop on the farmer's field during 1993-94 to 2016-17. It was found that there is an increasing trend in consumption of fertilizer quantity and consumption of fertilizer (Nitrogenous and phosphorous) remain the same over 20 years in the study area. Although, yield of paddy per unit of area is increasing but the farmers are operating in third phase of production.

Keywords: Efficiency, fertilizer, paddy, returns

Increased production pressure on limited land resources has led to several intensive cropping systems. This has also resulted in depletion of nutrients which are to be replenished to keep the soil productivity and ensure high yield for along with time, balanced fertilizer implies important in supply of nutrient while maintaining or improving the fertility of the soil without any harmful effect on environment, through the use of essential secondary and micro-nutrients in addition to NPK to obtain high yield. Continuous but imbalanced use of nutrients poses problems like toxicity due to high quantity of salt as residue of fertilizer, deficiency of some other nutrients deterioration of physical properties of soil impairing of aeration and soil-water-plant relationship resulting in decreased productivity. Organic manures solve this problem as it helps in increasing absorptive power of soil. An attempt has been made to analyze trend and pattern of chemical fertilizer consumption in production of paddy crop on the farmer's field during 1993-94

to 2016-17. Besides, attempt has also been made to find out law of return in paddy production for the sampled farmers.

MATERIALS AND METHODS

The present study is based on time series primary data, collected from the farmers over the years (1993-94 to 2016-17). A village namely MATULI, is located in Bikramganj block of Rohtas district, Bihar state. In the village near about 32 farm family are fully engaged in crop production. The cultivated area is fully canal irrigated area and Paddy-wheat is main cropping pattern. Out of 32 farmers, 13 farmers were purposively selected for collection of data. Among 13 farmers 2 were small category, 4 semi-medium and 7 medium category farmers, respectively. The fertilizer consumption data in paddy crop production was collected from the same selected farmers in each year i.e. 1993-94 to 2016-17 at different years by the first author.

Statistical model

The trend of fertilizer consumption/ applied of chemical fertilizer in Paddy crop production was carried out and presented in tabular form. The response of fertilizer in Paddy crop productivity was analyzed through Linear Regression model with the help of following form:

$$Y = a + b_1X_1 + b_2X_2$$

Where,

Y = Average yield of paddy/hectare in quintals per year

X_1 = Average quantity of Nitrogen in Kg/hectare/ year

X_2 = Average quantity of Phosphorus in Kg/hectare/ year

a = Intercept

Estimated variables

Yield per hectare (Y): The average yield per hectare per year was calculated by taking yield of all sample farmers in a particular year, example yield per hectare in year 1993-94 of all farmers and number of sample farms means mean of output (Y) in 1993-94. Similar process has been followed for measure (Y) from 1994-95 to 2016-17 respectively.

Nitrogenous fertilizer (X_1): For the calculation of X_1 inputs, the same process was followed as was used in case of output (Y) per hectare per year measurement. The average quantity of nitrogen applied by the farmers in the particular for production of paddy. The average quantity of nitrogen in 1993-94 to 2016-17 denoted by X_1 .

Phosphorous/hectare/year (Kg): For the calculation of X_2 input again same process was followed as was used in measurement of X_1 in the study. The average quantity of Phosphorous in 1993-94, 1994-95, 1996-97, 1998-99, 2005-06, 2013-14 and 2016-17 was denoted by X_2 .

RESULTS AND DISCUSSION

Size of farm holdings

The number of sample farms and their average size

of farm holding are presented in table 1. The total sample farmers were thirteen comprising their small farmers, semi- medium and seven medium farmers in ration of 15 %, 31% and 54% respectively. The size of farm holding was 3.93 hectares which varies from 1.60 hectare to 5.13 hectare. Paddy is a sole crop of *Kharif* season in the study area. Besides cent-percent cultivated area is a irrigated area by *Sone-* canal irrigation and there is a least occurrence of drought in the area.

Table 1: Number of farmers and their average size of holdings

Category of farmers	Number	Average size of holding (ha)	Area under paddy (ha)	Proportion of farm size
Small	2	1.60	1.60	15.00
Semi Medium	4	3.00	3.00	31.00
Medium	7	5.13	5.13	54.00
Total	13	3.39	3.39	100.00

Application of plant nutrients in paddy

The Table 2 shows that altogether 96.25 Kilogram of fertilizer nutrients in form of N (Nitrogen) and P (Phosphorous) was applied by the sample farmers in their paddy crop in year of 1993, in production of 66.25 Kilogram and 30.00 Kilogram of Nitrogen and Phosphorous, respectively per hectare. During 1998-99. The total quantity of fertilizer use has increased to a level of 106.25 Kilogram per hectare in a ratio of 72.25 Kilogram and 34.00 Kilogram of Nitrogen and Phosphorous respectively. The quantity of nutrient was substantially increased in 2005-06 from base year 1993-94, altogether the quantity per hectare was applied to 150.00 Kilogram in proportion of 108.0 Kilogram of Nitrogen and 42.0 Kilogram of Phosphorous, respectively.

Productivity of paddy

The average yield per hectare of paddy and yield per Kilogram of fertilizer nutrient are also presented in Table 2, which revealed that there was constant increasing trend except 1996-97 in yield of paddy was obtained in the study area. The average yield of paddy was recorded to 52.96 quintals per hectare

in the 1993-94, further increased to 60.75 quintals in 1997-98 from a level of about 55.0 quintals in 1996-97. From the year 1997-98, an increasing trend was maintained up to the year of 2016-17 and reached a significant level of 71.25 quintals per hectare indicating 35% positive change during 1993-94 to 2016-17. During last ten years, a strong jump was seen in application of fertilizer consumption in the study area and the total quantity of fertilizer consumption reached to a level of 214.0 Kilogram per hectare with a combination of about 184.0 Kilogram of Nitrogen and 30.00 Kilogram of Phosphorous. It was also found there was no much change in application of Phosphorous quantity in the study area in paddy crop. In case of Nitrogen application in paddy crop magnitude of positive change was recorded to be 177.36 % during 1993-94 to 2016-17. The overall changes in fertilizer consumption during 1993-94 to 2016-17 were found to be 122% in the sample area.

Table 2: Consumption of plant nutrient in paddy crop per unit of area of sample farmers (Kg/hectare)

Year	Nitrogen (Kg)	Phosphorous (Kg)	Total (Kg)	Yield (Q/hectare)	Yield/Nutrient (Kg)
1993-94	66.25	30.50	96.25	52.65	54.70
1994-95	64.00	33.00	97.00	56.70	58.45
1996-97	66.25	30.00	96.45	54.68	56.70
1997-98	69.25	26.00	95.25	60.75	63.77
1999-00	72.25	34.00	106.25	61.00	57.40
2005-06	108.00	42.00	150.00	62.50	41.67
2013-14	135.65	36.00	171.65	65.00	37.86
2016-17	183.75	30.00	213.70	71.25	33.34

Yield per unit of nitrogen

The nutrient efficiency per unit of fertilizer was analyzed in paddy production and revealed that during 1993-94, the yield of paddy per unit of nutrient was obtained to be about 55 kilogram which increased to about 58 kilogram in 1994-95 and further accelerated to about 64 kilogram in 1997-98. The increasing trend was maintained during 1993-94 to 1997-98 except during 1996-97. After 1997-98 onward the declining trend was obtained in per unit of nutrient efficient in paddy production (table 2). In the quantity term, the per unit of nutrient, the paddy

output was nearly 57 kilogram further declined to about 42 kilogram in 2005-06 and this trend maintained in year 2013-14 and reached to a lower level of nearly 33 kilogram in 2016-17. The nutrient efficient per unit in paddy production declined to 64 per cent during 1993-94 to 2016-17.

To study the relative influence of each of the two explanatory variables, which are likely to have effect on the yield of paddy production by the farmers, linear regression model was applied. The yield (Y) was per hectare in quintal and two variables namely nitrogen and phosphorous were taken in kilogram as explanatory variables determining the productivity or yield of paddy on the sample farmers.

Table 3: Regression coefficients, standard error and coefficient of multiple determination (R^2) of yield of paddy on the sample farmers

Parameters	Estimate	Standard Error
Intercept	19.77	
Nitrogen (X_1)	0.127***	0.024
Phosphorous (X_2)	0.028	0.114
Coefficient of multiple determination (R^2)	—	0.840
Adjusted coefficient of multiple determination	—	0.782

*** Significant at 0.01 per cent level.

In Table 3, the size of the coefficient of multiple determination (R^2) shows that degree of success in estimating the yield relationship and selection of explanatory variables. It shows the percentage of variation in yield, which were explained by included variables. It can be seen from the table 3 that it was estimated as 84 per cent indicating that major portion of the variations in yield of crop were captured by the related variables (Nitrogen and Phosphorous).

The co-efficient of nitrogen was found significantly different from zero at one percent level. This variable also bears positive sign. This sign of the variables indicates that any increase in quantities of nitrogen in paddy cultivation on the sample farmers would result into an increased yield of paddy. However the coefficient of input is less than unity indicating that the law of diminishing return was operating with respect to these variables. The high level of

significance of nitrogen coefficient indicated that the sole determinant of high yield of paddy is nitrogenous fertilizers. The efficiency of Nitrogenous fertilizer is 30-40% in paddy, while the efficiency of phosphorous fertilizer is 15-20 % in this crop (Fertilizer consumption", Agriculture Today- 2017).

CONCLUSION

It can be concluded from the study that there is increasing trend in consumption of fertilizer quantity and consumption of fertilizer (Nitrogenous and phosphorous) remain the same over 20 years in the study area. Although, yield of paddy per unit of area is increasing but the farmers are operating in third phase of production. Per unit of nutrient efficiency is also declining mainly due to year after year declining/imbalance of soil nutrient. It is an urgent need to convince farmers about bad effect of imbalance use of chemical fertilizer in crop production.

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