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Estimating the Effect of Fertilisers on Rice Yields In Assam: a Panel Data Analysis

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ABSTRACT

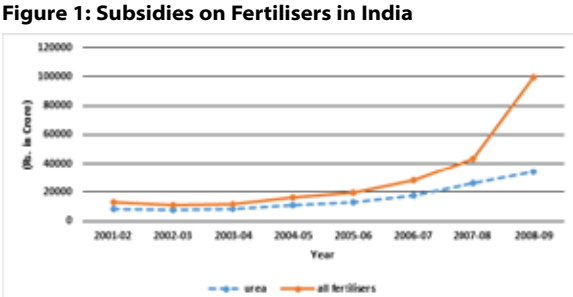
Rice cultivation is the chief occupation of the rural economy of Assam and provides food to more than 25 million people, in addition to generating income and employment directly and indirectly. Fertilisers, along with better seeds and water, play a critical role in enhancing the productivity of rice. The present study looks at rice cultivation in Assam and estimates the impact of fertilisers use on rice yields, showing that the relationship is negative up to a point (underuse of urea), beyond which the impact of the additional use of fertilisers on yields is positive. A panel data analysis has been used to capture the effect of fertilisers, especially urea. The results suggest that there is still under-consumption of urea in the region which is affecting the rice productivity.

KEYWORDS : optimal ratio, urea usage, yield

Introduction

In India, the fertiliser subsidy accounts for a major share in the total government expenditure. India today is one of the largest producers and consumers of fertilisers in the world.[1] It accounted for 13.7 per cent of the world's N consumption, 14 per cent of phosphatic (P2O5) and 7.9 per cent of potassic (K2O) nutrients in 2006-07.[2] Its production and consumption of urea has increased to a level of 211.21 and 266.73 lakh MTs respectively in 2009-10.[3] In the year 2001, the share of urea subsidies[4] was around 55 per cent which increased to 193 per cent in the year 2008.

Figure 1: Subsidies on Fertilisers in India



Source: Indiastats.com

Fertiliser subsidies have increased significantly from 2004 onwards. Fertiliser subsidies have grown to become one of the largest spending items of the agriculture sector. As Figure 1 shows, by end-2008 the amount allocated to urea fertilisers has increased significantly. In this paper we will look at rice cultivation in Assam.

The cultivation of rice is the chief occupation of the rural economy of Assam and provides food to more than 25 million people, in addition to generating income and employment directly and indirectly.[5] It is a staple food of Assamese of all ages, influencing the cropping pattern of the state.

The state has its climatic and geographical features and fertile soil of the Brahmaputra valley favorable for rice cultivation and the crop is grown in a wide range of agro-ecological situations.[6] In Assam four kinds of rice are cultivated throughout the year. These include: Ahu, Sali, Boro and Hill rice. However, given the climatic and geographic conditions, the farmers in Assam are not able to take full advantage of fertiliser subsidy given by the government. The share of Assam in total urea subsidy has increased marginally from 0.2 per cent in 1992-93 to 0.8 per cent in 2007-08.[7]Though cultivation of rice requires optimal combination of nitrogenous, phosphorous and potassium fertilisers, but the focus of this paper is on urea, since this fertilisers represents the bulk of the fertilisers used by rice farmers and it captures most of the subsidies being provided to the fertiliser industries.

The Government of India's Fertiliser Subsidy Program seeks to increase agriculture productivity and aims to increase the availability and consumption of fertilisers at affordable prices in the country[8]. The annual consumption of fertilisers in Assam, in nutrient terms (N, P & K), has increased by 11.6 per cent during the years 1970-2000 and per hectare consumption, has increased from 49.5 Kg in 2003-04 to the level of 63.16 Kg in 2009-10.[9] The recent literature suggests that the marginal productivity of soil in relation to the application of fertilisers is declining. According to Talukdar & Beka (2005) "comparatively high usage of straight fertilisers (Urea, DAP & MOP) as against the complex fertilisers (NPKs) which are considered to be agronomically better including low or non-usage of secondary and micro nutrients has contributed towards slowdown in growth of productivity. The declining fertilisers use efficiency is also one of the factors for low productivity. The pricing of subsidized fertilisers is also probable responsible for higher usage of straight fertilisers and skewed usage of nutrients". If we look at the correlation between fertiliser consumption and food grain yields for Assam, then for the year 1990s it was around 0.8343 which became negative 0.4823 in 2000's.[10] It is therefore, necessary that farmers should use optimal amount of fertilisers on their fields.

The optimal NPK ratios as recommended by Ministry of agriculture for rice cultivation in Assam is 3:1:2. However, table 1 suggests that NPK ratio in Assam is far below the optimal level.

Table 1: NPK Ratio in Assam

State	2004-05	2005-06	2006-07	2008-09	2009-10	2010-11	2011-12	2012-13
Assam	2.1:1.4:1	1.9:1.2:1	2.1:1.0:1	1.8:1.0:1	2.0:0.8:1	1.9:0.8:1	2.0:0.6:1	2.0:0.6:1

Source: Gulati & Banerjee, 2015

In this paper we will look at rice cultivation in Assam and estimate the impact of fertilisers use on rice yields, showing that the relationship is negative up to a point (underuse of urea), beyond which the impact of additional use of fertilisers on yields is positive.

Data and Methodology

This section estimates the impact of urea use on rice yields in Assam. A simple panel-data model using random effects for the years 1990-2010 (21 years) has been taken from ICRISAT VDSA database. About ten rice growing districts of Assam has been analyzed which includes: Cachar, Darrang, Dibrugarh, Goalpara, Kamrup, Karbi Anglong, Lakhimpur, North Cachar Hill, Nagaon and Sibsagar. The model proposed allows for diminishing returns to the use of urea (by including a quadratic term for urea used), implying that there is an optimal point for urea usage beyond which yields start to decline. The impact of urea on rice yields is dependent on: the quantity of urea used, use of HYV seeds, annual rainfall and the consumption of other fertilisers (potassium and phosphorous) and dummy variables are defined for agro-climatic zones. Since,

rice yields are affected by climatic conditions such as the rainfall pattern, terrain and soil characteristics, so take account of this factor Assam has been delineated into six agro-climatic zones *viz*. North Bank Plain Zone (Darrang, Lakhimpur), Upper Brahmaputra Valley Zone (Sibsagar, Dibrugarh), Central Brahmaputra Valley Zone (Nagaon), Lower Brahmaputra Valley Zone (Goalpara, Kamrup), Barak Valley Zone (Cachar) and Hill Zone (North Cachar Hills, Karbi Anglong districts).[11] The Barak Valley Zone is considered as reference category. The effect of agro-climatic zones have been captured through dummy variables.

The model to be estimated is summarized below:

$Yield_{it}=\alpha+ \beta_1 urea_{it} + \beta_2 potass_{it} + \beta_3 phos_{it} + \beta_4 HYV_{it} + \beta_5 rainfall_{it} + \beta_6$ urea_sq +d1 NBPZ+ d2 UBVZ+ d3 LBVZ+ d4 CBVZ+ d5 HILL ZONE+ ε

Variable definition:

Where i' stands for district and t for year
yield is the quantity of rice (kg/ha)
urea is the quantity of urea used (kg/ha)
urea_sq is the square term of urea used
land_size is the size of the cultivated rice field (ha)
rainfall in millimeters
HYV is area under HYV seeds (ha)
potass is the quantity of potassium used (kg/ha)
phos is the quantity of phosphorous used (kg/ha)
d1, d2, d3, d4, d5 are dummy variables for agro-climatic zone.
ε is error term

Results:

The results below indicates that there is a positive impact on rice yields when using urea at adequate levels. The model clearly shows that that a 1 percent increase in urea use decreases yields by 10 percent in Assam. Other variables such as rainfall is positively associated with rice yields, phosphorous is also positively associated with yields and significant too, whereas potassium and HYV area are negatively related. The model supports the thesis that inefficient application of urea will have an adverse impact on rice production (as urea_sq term is positive).The dummies for North Bank Plain Zone (D1), Central Brahmaputra Valley Zone (D4) and Lower Brahmaputra Valley Zone (D3) are showing significant impact on yields.

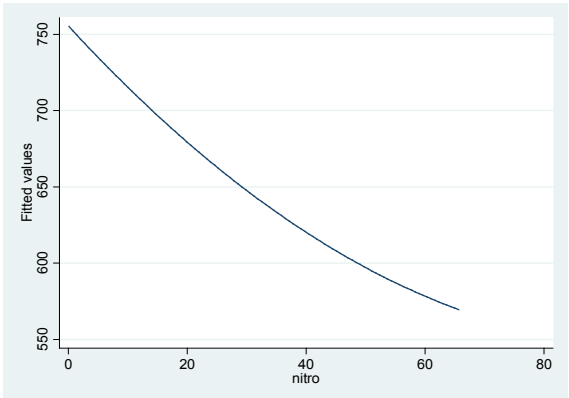
Table 2: Regression Results

Dependent variable: rice yield	Co-efficient
Urea	-11.78209 (2.369099)**
Phos	10.5377 (2.641341)**
Potass	-4.883487 (3.042547)
Urea_used	.0827376 (.0327338)*
Rainfall	.0018003 (.0063412)
HYV area	1.867288 (.9688831)
D1	226.3954 (30.29348)**
D2	27.43328 (26.18991)
D3	274.4987 (29.28378)**
D4	114.6538 (34.07958)**
D5	-1.838805 (39.32762)
α	550.6277 (89.51073)**

Source: Author's calculation
** Significant at 1%
*Significant at 5%

The figure in the bracket indicates standard error

Figure 2: Urea and rice yields in 1990-2010 model estimation



Thus, Figure1 depicts there exist a 'U-shaped' relationship between rice yields and urea usage. It suggest that there is a need for optimal application of urea fertiliser on fields so as to increase rice yields in the state. The model estimates the threshold at which the relationship between urea used and yields reverses at 72 (kg/ha) and in line with the recommended amounts by the Ministry of Agriculture at 70-80 (kg/ha).The underuse of urea in Assam, particularly when compared with some of its regional peers, and its positive impact on soil quality, are well documented[12]. This is mostly the result of distorted factor prices and inadequate supply of urea in the north-east regions.

Conclusion

The study has concluded that there has been an inadequate use of urea in the cultivation of rice in the region. Rice being the basic staple food of Assam and also a major component of national food security scheme, there is a need for a greater attention on improvement in its production. The main reason that emerges from the analysis is that the inadequate usage of urea is not because of its high price but the non-availability to the farmers. At present, organizations like IFFCO, BFVFCL, Green Chemicals Ltd, Teesta Agro Industries Ltd. have been playing a pivotal role in the distribution of fertiliser through their respective branches located at various corners of the State. However, in the year 2015 the government has proposed to set up a new fertiliser plant in Namrup in Assam. These efforts by the government aims to increase the availability of urea in the region. Thus, rice productivity can be increased through optimal usage of urea and better irrigation facilities which will help the state to achieve its food security goal in the near future.

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