International Journal of Modern Agriculture, Vol. No 10, Issue No. 2 (2021)
ISSN: 2305-7246

NITROGEN FERTILIZER USE IN AGRICULTURE AMONG MARGINAL AND SMALL FARMERS IN INDIA: REVIEW OF IMPORTANT DRIVERS

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Abstract

Nitrogen, in practice, has been an integral input component in our food production system. The application of synthetic nitrogen in agriculture, which was essential with high yield varieties, has been moving parallel since green revolution. Amendment and regulation of agriculture related acts, polices and extended subsidies have significant link with the different size of farmers to use nitrogen fertilizer. However, sarcastically the intensity of using nitrogen fertilizer in agriculture found to be higher among marginal and small farmers. Moreover, the economic and the environmental cost of production have been increasingly higher than return from agriculture. The economic and environmental implication of increasing nitrogen use lead to issues of declining nitrogen use efficiency, low fertility, economic loss, and decline in soil and water quality. The use of nitrogen fertilizer in agriculture is being driven by various factors related to economic, social, geographical, demographic, institutional, ecological, political and commercial dimensions. However, this paper classifies the nitrogen use drivers, from the existing literature, into price and non-price dimensions. The paper has attempted to answer the following research question through reviewing the related literature and secondary data: what factors drive the marginal and small farmers to use nitrogen fertilizer?

Key words: Drivers, Determinants, Nitrogen Use, Marginal and Small farmers, Price, Non-Price

Introduction

Agriculture contributes about 15.96 per cent to the Gross Domestic Product and provides a survival to near about two third of the Indian Population. With the growing population, it is important for the economy to secure its population with food security. From traversing food deficit and the food grain import country during and after independence, India had slowly reshaped to food surplus, self-sufficient and net exporter of food grains in the global scenario. The advent of green revolution led a stone of the use of technology, high yielding variety seeds, synthetic fertilizer and irrigations to improve production and productivity. The food grain production increases from 52 million tons in 1951-52 to 285 million tons in 2018-19.

Subsistence evidence has also determined the increasing role of synthetic fertilizer in sustaining food grain production. Fertilizer production and consumption has been increasing in India over the decades and currently it is the second largest consumer of complex synthetic fertilizer i.e. NPK after China and third largest producer after China and USA. As the seventh largest nation in the world with 329.7 million hectare area, it has a net cultivable area of 141 million hectares and cropping intensity of 135 per cent. In 1970-71, the consumption of Nitrogen (N) fertilizer was only 0.14 thousand tons, which rapidly increases to 17.63 Million MT in 2018-19 (FAI 2020). Nitrogen fertilizer is tamed to be both essential nutrients in increasing crop yield and quality and pollutant in terrestrial ecosystem (Khajuria 2016). Thus, it is important to make effective use, so as to release maximum benefit in terms of nutrient infiltration to the soil and improve crop productivity and minimum losses in terms of leakage and leaching. Recent studies have found the soil fertility in India has declined due to poor adoption of best nutrient management practices. Significant differences in average intensity of fertilizer have been found in various regions such as 40.7 kg per ha in western region while 227 kg per ha in the Northern region in Punjab. The NPK consumption ratio deteriorated since 4.7:2.3:1 during 2010 to 8.2:3.2:1 during 2012. The huge difference in ratio has been seen at the different regional level. The NPK ratio in the Indo-gangatic region is abruptly low with response to the huge food grain contribution. In Punjab it is 61.7:19.2:1, in Haryana

61.4:18.7:1, in Uttar Pradesh 25.2:8.8:1. The present imbalances in the use of NPK ratio have created the problem in declining soil productivity and farmers Income, which are both economic and environmental losses.

Farmers who are the primary consumer of fertilizer in Agriculture have been inevitable to various circumstances to apply straight and complex fertilizer, in order to enhance their productivity and production. Different category of farmers, irrespective of their land size demands for synthetic or inorganic fertilizer, which instantly shows its result on plants. The Decision to adopt or use synthetic fertilizer has been driven by various factors. The existing sets of literature classify it as price factors and non-price factors, which influence the behavior of the farmers. Since the intensity of use of fertilizer, particularly the straight fertilizer i.e. NPK, it is found that there is a huge distortion and difference between various states and regions.

Input Survey (2011-12) reported that around 58 per cent of the marginal and small farmers adopt nitrogen fertilizer such as Urea, Ammonium Sulphate, Calcium Ammonium Nitrate, Ammonium Chloride and few other Nitrogen contain complex fertilizers in around 48 per cent of the land holdings. Moreover, the flexible subsidy on urea pushes them to use more in an inefficient way. Studies on marginal and small farmers supported with reasons such as low awareness, lack of education, lack of extension and adoption techniques, perception to increase the production (Sharma and Thaker 2011)(Jaga and Patel 2012). The higher and inefficient use of nutrient scientifically remains a loss on the environment and economic face of agricultural practices. On the economic front the high cost of production which has not been supported with the economic return realized by farmers (Pani et al. 2020). The high overdoses of application not only negatively impacted soil and water bodies, but also seen as an economic loss. The eco-environmental problem has been stressed with practicing conservation agriculture, where loss of nitrogen and other synthetic chemical use, pesticide use has been taken into consideration. Hence, the inefficient and quantity use of fertilizer among the small and marginal farmers over the period remains higher, resulting to declined efficiency rate" and socio-economic and environment losses.

Despite of environmental degradation and losses as well as economic loss, the adoption towards the use of nitrogen fertilizer remains to be high and keep on increasing year on year among marginal and small farmers, who are more vulnerable to these consequences of economic and environmental impacts. Hence the study is an attempt to answer the related question (1) does the standard application dozes is not sufficient to retain maximum productivity? (2) What factors drive the marginal and small farmers to use nitrogen fertilizer? The paper is an attempt to review the factors influencing the behavior of marginal and small farmers in using Nitrogen fertilizer along with policies related to it.

Material and Methods

To attempt this paper, we have undergone through a search of a series of relevant secondary work. We obtained relevant quality literature from journals indexed in Scopus, Research gate and Google Scholar, grey papers, Policy and committee documents. The following sets of secondary data were brought from Agricultural Census, Input survey, Agricultural Statistics, Annual report Fertilizer Association of India, Budget documents. The relevant secondary data were brought, plotted in excel sheet, were analyzed and interpreted. The author in its next chapter presented the status of nitrogen fertilizer and Marginal and Small farmers' consumption.

The third section is about reviewing the factors influencing the behavior of marginal and small farmers in using nitrogen fertilizer. Lastly the study is concluded with highlighting the relevant literature gap in the existing body of literature and strategic conclusion which can be further carried out both empirically and practically.

Status of Nitrogen fertilizer use by marginal and small farmers

Nitrogen fertilizer as a plant nutrient is essential for plant growth and increasing the production and productivity to meet the food grain demand of the growing population. Rice and Wheat as a principal crop across the country consumes the highest amount and bear high intensity in consumption practices. The studies reflect that 78 per cent of gaseous nitrogen (N2) has been limitlessly reserved; having a strong triple bond between the two

nitrogen atoms makes the gas inert and not directly used by plants and animals. Reactive nitrate (NO3-), ammonium (NH4+), urea, which rapidly hydrolyses to form NH4+, to the terrestrial biosphere through fertilization process, hence has been recognised as the effective method for increasing food production (Galloway 2000). Moreover, the process has been negatively resulted due to excess fertilizer application, resulting in various global, regional, local environmental problems (He et al. 2011) ozone depletion, soil acidification, ground water pollution, and the leaching effect which further impacted on productivity. The period of pre-green revolution has been subjected to major reforms in agriculture, industry, institutional changes and irrigation projects. Bringing out High yielding variety of seeds, new methods and technology, fertilizer application, lending subsidy to industry on production and marketing of Urea were a few provisions to enhance the food production.

To meet the food grain production and unavoidable circumstances of shortage of food grains, production of nitrogen fertilizer increased at an annual growth rate of 26.4 per cent during pre-green revolution stage. During the phase of green revolution in till 1990 it increased at a growth rate of 22.9 per cent due to change in polices, programme and a huge focus on agricultural development, irrigation project, RPS schemes during 1977. However, during the post reform period, there has been a drastic fall in performance due to shift in policy reform and growing at an annual growth rate of 3 per cent per annum.

The consumption of particularly Nitrogen has adorably increased due to the low price of Urea. However, the consumption demand has increased the Nutrient consumption ratio ahead of the ideal standard level i.e. 4:2:1. Presently the NPK consumption ratio remains to be 7.1:2.7:1 (2018-19) from 6.0:2.4:1 (1990-91) and declines the efficiency of nutrient use (Figure 1).

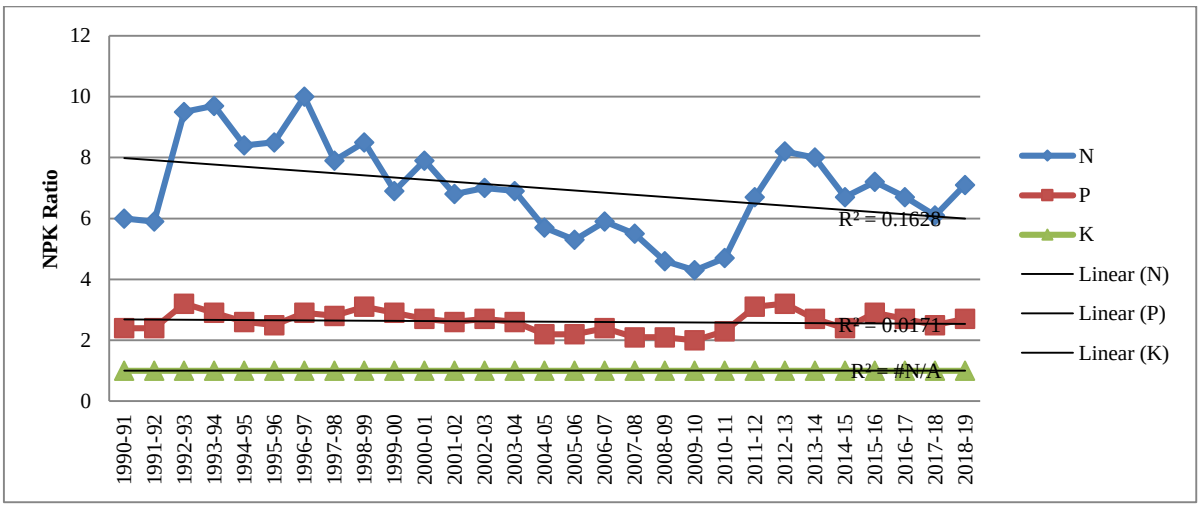

Figure 1. NPK consumption in India Since 1990

Source: Indian Fertilizer Scenario, 2018-19, Fertilizer Association of India

The consecutive table 1 reflects the farm size consumption of fertilizer and also specifically nitrogen fertilizer in India in 1991-92, 1996-97, 2001-02, 2006-2007 and 2011-12. It is evident from the table that with share of less than 4 per cent in land holding, medium and large farmers consumed about 28 per cent of total fertilizer and about 21 per cent of nitrogen fertilizer in India in 2011-12. Semi- Medium farmers accounts for 9.5 per cent of the total land holding but consumed 24.13 per cent of total fertilizer and about 20 per cent of nitrogen fertilizer. On the other hand, Marginal and small which accounts for more than 86 per cent consumed 49 per cent of total fertilizer and 58 per cent of nitrogen fertilizer.

Table 1. Pattern of Fertilizer Consumption by Farm Size

Farm Size	Marginal	Small	Semi-Medium	Medium	Large
Distribution of landholding (%)					

1991-92	57.1	20.3	13.7	7.3	1.6
1996-97	60.7	18.9	12.5	6.5	1.4
2001-02	64	18.2	11	5.6	1.2
2006-07	64.8	18.5	10.9	4.9	0.85
2011-12	67.5	17.5	10.04	4.24	0.7
2015-16	68.45	17.62	9.55	3.79	0.57
Share in gross cropped area (%)					
1991-92	17.3	19.6	23.8	25.8	13.5
1996-97	19	19.1	23.5	25.1	13.3
2001-02	22.3	20.3	22.8	22.9	11.7
2006-07	23.42	20.94	22.95	22.45	10.21
2011-12	24.8	22.46	23.55	20.68	8.44
Proportion of area treated with fertilizer to gross copped area (%)					
1991-92	63.6	62.6	60.9	58	46.9
1996-97	64.1	62.7	60.8	57.4	45
2001-02	77.1	74.2	71.3	65.1	49.7
2006-07	73.4	77.15	76.5	72.3	61.75
2011-12	77.69	78.36	77.71	74.0	63.17
Share in total fertilizer consumption (%)					
1991-92	20.6	21.1	24.2	23.9	10.2
1996-97	25.6	20.4	23	22.2	8.8
2001-02	29.9	22.1	22.1	18.9	7.0
2006-07	23.74	22.1	23.87	22.1	8.16
2011-12	25.44	23.2	24.13	20.14	7.02

Source: Input Survey, 1991-92, 1996-97, 2001-02, 2006-07, 2011-12

Moreover, when we look at the share of farm size in the area and fertilizer consumption, it gives a peculiar and different view. In 2011-12, the share of marginal and small farmers in the gross cropped area was about 48 per cent and consumed 49 per cent of the total fertilizer. But the share of medium and large farmers in the gross cropped area was 29 per cent and consumes about 28 per cent of total fertilizer. There has been a significant trend where about 78 per cent of the gross cropped area was treated under fertilizer.

It has been evidently reflected that marginal and small farmers' intensity of nitrogen fertilizer use is more as compared to medium and large farmers. The nitrogen fertilizer consumption per hectare of gross cropped area was highest among Marginal and small farmers i.e. 117.9 kg in 2011-12 and was on a similar increasing trend. Various driving factors were responsible for intensively consumption of nitrogen fertilizer (Table 2). However, the judicious and effective use of plant nutrient needed for low economic and environmental losses and to protect from vulnerability to marginal and small farmers.

Table 2. Pattern of Nitrogen (N) Fertilizer Use Intensity by Farm Size

Farm Size	Marginal	Small	Semi-Medium	Medium	Large
N Fertilizer Consumption per hectare of Gross Cropped Area (kg)					
1996-97	64.8	49.89	46.7	43.9	34.12
2001-02	73.12	58.27	52.55	47.34	36.9
2006-07	86.2	76.5	67.7	61.5	45.2
2011-12	117.9	76.5	67.7	61.2	55.8
N fertilizer consumption per hectare of fertilizer area (kg)					
1996-97	101.1	79.6	76.9	76.5	75.7
2001-02	95.4	78.02	72.6	70.7	71.68
2006-07	117.1	99.9	89.7	86.12	77.9

2011-12	151.7	97.6	87.17	82.7	55.5
Share in N fertilizer consumption (%)					
Farm Size	Marginal	Small	Semi-Medium	Medium	Large
1996-97	25.4	19.6	22.7	22.8	9.3
2001-02	27.51	22.32	23.12	20.05	6.9
2006-07	28.75	22.83	22.14	19.68	6.58
2011-12	36.6	21.5	19.9	15.88	5.9

Source: Input Survey, 1991-92, 1996-97, 2001-02, 2006-07, 2011-12

Table 3. Share of Paddy and Wheat Area Treated with Fertilizer to Gross Cropped area (%)

	Paddy				Wheat			
Farm Size	1996-97	2001-02	2006-07	2011-12	1996-97	2001-02	2006-07	2011-12
Marginal	75.31	84.5	78	86.19	76.0	93.5	94.35	86.98
Small	72.26	81.4	79.4	86.13	75.8	91.1	92.12	86.9
Semi-Medium	69.6	78.1	78.9	85.3	77.6	90.2	91.66	88.5
Medium	69.7	77.2	76.02	85.38	79	89.2	91.03	89.8
Large	71.7	75.9	77.3	82.19	80.1	87.3	88.9	91.54

Source: Input Survey, 1991-92, 1996-97, 2001-02, 2006-07, 2011-12

Table 4. Share of Paddy and Wheat Treated with Nitrogen Fertilizer (%)

	Paddy				Wheat			
Farm Size	1996-97	2001-02	2006-07	2011-12	1996-97	2001-02	2006-07	2011-12
Marginal	33.9	34.22	37.4	41.23	22.4	26.7	29.3	35.97
Small	21.6	23.24	22.31	20.57	16.24	17.92	19.3	16.03
Semi-Medium	20.79	20.78	20.5	18.33	21.6	21.4	21.18	18.4
Medium	17.11	16.2	15.13	14.55	26.84	23.54	21.81	20.5
Large	6.4	5.53	4.6	5.3	12.8	10.4	8.2	9.05

Source: Input Survey, 1991-92, 1996-97, 2001-02, 2006-07, 2011-12

Rice and wheat remained to be the principal field crop across the country and across all farmers' size followed by residue crop such as gram or second crop such as groundnut, sugarcane, maize. Although diversification in cropping pattern has taken place, but food grain productions are inevitable with relation to polices, programme, society & culture, market, climate and geographical diversity. The share of the paddy area with fertilizer to the gross cropped area was remained to be higher among marginal and small farmers. But the share of Wheat area with fertilizer to the gross cropped area was remained to be higher among large farmers. However, the consumption of nitrogen fertilizer remained to be higher among marginal and small farmers in both paddy and wheat crop at an increasing trend. Studies reflected that the nitrogen use efficiency in paddy has been declining at a faster rate, which remained to be un-sustainable for both economic and environmental. Figure 2 and 3 reflect an economic difference between the cost and MSP of paddy and wheat. The high cost of cultivation also includes the nutrient procurement and application.

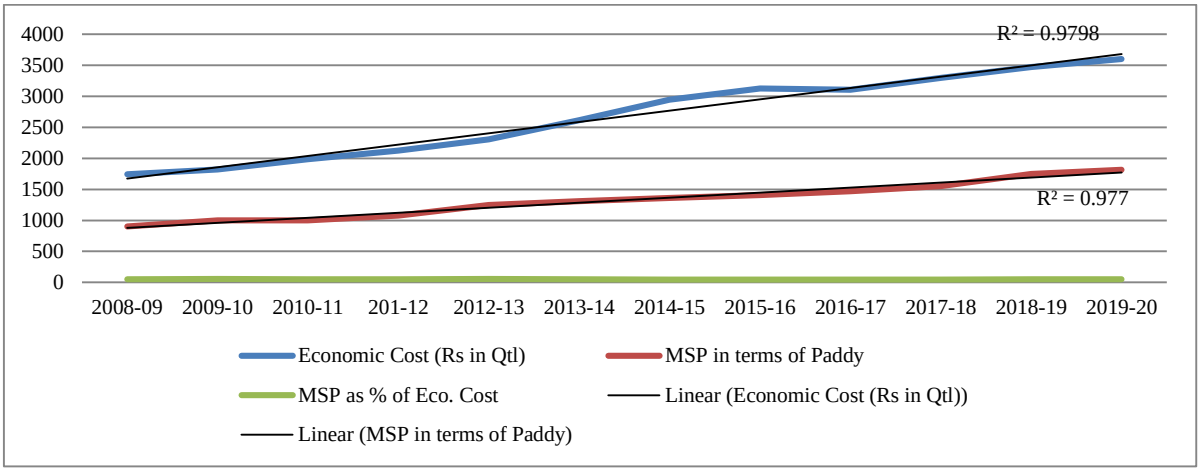

Figure 2. Economic difference between cost and MSP of paddy
Source: Food Corporation of India, http://fci.gov.in/

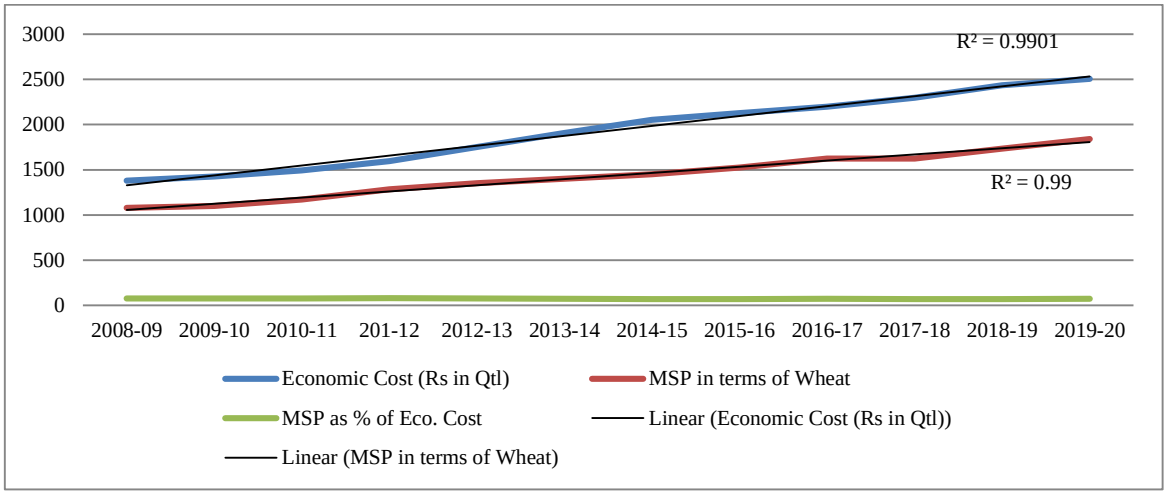

Figure 3. Economic difference between cost and MSP of wheat
Source: Food Corporation of India, http://fci.gov.in/

Consumption of fertilizer as a nutrient is an important and necessary requirement for improving crop production and productivity. Paddy and wheat as a principal crop consumed nearly 65 per cent of the total fertilizer consumption. Nitrogen fertilizer accounts for nearly two-third of the total nutrient consumption. Urea as a straight nitrogen fertilizer account for 80 of total consumption and its use is highly varied across different crops, region and among the size of farmers due to various price and non-price factors. The status of nitrogen fertilizer and intensity of use is higher among marginal and small farmers. Hence it raised a question of 'what are the important drivers that influence marginal and small farmers to use nitrogen fertilizer and why the trend has been significantly increasing over the period.

The next section of the paper reviewed the factors influencing the behaviour of marginal and small famers in using nitrogen fertilizer.

Drivers of Nitrogen Fertilizer Use among Marginal and small farmers

Consumption of Fertilizer in India has been increasing in India over time with the necessity of meeting the food grain demand. India is one among the largest producers and consumers of indigenous fertilizer in the world. Among the nitrogen fertilizer, there is straight and complex fertilizer which helps for yield improvement and production growth. Over the time, as it has been found that the nutrient content in soil is has remained deficit to the plant growth. Fertilizer consumption, specifically nitrogen fertilizer, which has temped the farmers to use

more and more over the period due to certain price and non-price factor. Intensity of use of nitrogen fertilizer across the farm size and state wise has seen to be significantly varied and it is important to understand the user behavior and factors influencing or driving or inducing them to use. Various studies have undertaken to understand the consumption behavior linking demand to various price and non-price factors. Non price factors such as Agro-ecology & technology (Rainfall, Irrigation, High yielding variety), demographic factors (education, extension, health, nutrition), financial capital Formation (income level, credit availability, assets), Government policies (taxes, subsidy, investment in Research and development), basic services (Bank, infrastructure, quality control), organizational structure (industry performance, sector performance, structure) and price factor such as output demand, price of output, price of inputs)(Chadha and Meena 2019; Chakraborty 2016; Ghosh 2003; Khajuria 2016; Kundu and Vashist 1991; Mala 2013; Malik and Sekhar 2007; Ravinutala 2016; Subramaniyan and Nirmala 1991)

Fertilizer as a nutrient was critical to the green revolution, to support government of India passed Fertilizer control Order in 1957 to regulate the sales, price and quality of fertilizer. Simultaneously, the movement control order was added in 1973 to regulate the distribution of fertilizer at a fair rate and with all accessibility. Till 1977 no subsidy was provided on Fertilizer. In 1977 government interceded by subsidizing manufactures. With economic crises and further revamping the economy with policy reform has stressed the economy with fiscal burden. The government wanted to decrease subsidies. DAP and MOP was decontrolled, but urea as the most abundantly used resources was controlled by the government. With increasing in the price of P and K in the market, farmers reduced the consumption and consumption of Urea as highly subsidized increased year on year.

Condition and external situation vary from geographic, demographic, infrastructural and economic conditions of the farmer. With response to the role of fertilizer, need for an increase in yield and application of doses relatively are correlated (Ramasamy.C 1986; Singh, Brar, and Sekhon 1976)and dependent of various non-price factor. The study found that improved varieties of seeds are a highly important factor.

The consumption of fertilizer and irrigation was an important feature of green revolution, which has simultaneously planned and regulate irrigation project in India. However the area under irrigation increased. Indian agriculture is mostly dependent on monsoon & featured with agro-climatic zone and around 63 per cent of the net sown area comes under rain-fed.(Jha and Sarin 1980) through a study in semi-arid tropical of India with secondary data from 1969-1979 found that around 62 per cent of nitrogen fertilizer used in irrigated area having only 35 per cent of the crop. Moreover the average consumption per hectare was 56 kg in irrigated area and 18 kg in un-irrigated area.

Output from crop production remains to be important for giving a balanced income to small farmers. Hence, cost and return are relative measurement. (Mehta and Singh 1982) stated that the extensioner and planner should provide the right quantity of dozes at the right time. Hence the availability of variable inputs improves the income generation capability among small farmers. Alongside fair, stable and remunerative price

Application of nitrogen fertilizer were certainly also influenced by proper management of nutrient where it has been taken to be very sensitive in terms of cost and procurement in wheat cultivation. Further small farmers decision has been influenced and shift by procurement plus delivery cost (Flinn and Shakya 1985).Application of fertilizer in a judicious and effective manner helped farmers not only to understand the application technique buy also reduces the economic and environmental losses.(Singh, Singh, and Bal 1987) revealed that although the yield has increased in consecutive years (1971-72; 1981-82; 1986-97) but the coefficient of variation in yield reflects a variation among various farm sizes. The coefficient of correlation between the nitrogen fertilizer application and yield on wheat and paddy showed that nitrogen fertilizer has significantly contributed in increasing the yield.

Malik and Sekhar 2007, and Sheoran and Nandal 1997determine the factors affecting the nitrogen fertilizer consumption in Haryana. Nitrogen responsive crop, irrigation and relative price (ratio of the price of fertilizer to price of output), share of crops area (Gupta 1983) has been the most influencing factor. Secondly availability of

adequate credit at right time was found to be a more important factor. However, it has been responded that credit availability unlikely to increase the dozes of application. Alternatively nitrogen fertilizer consumption can decrease if the price of N fertilizer may arise. (Gupta 1983) through multi regression it was exerted that area under high yielding variety and the credit tends to have less influence on nitrogen use. (Malik and Sekhar 2007) noted that soil health card remained to be insignificant for determining the use of nitrogen fertilizer. Application of N doses works irrespective of the results of soil health card among the majority of sampled farmers.

Liberalizing the policy environment for agriculture by subsidizing the nitrogen based fertilizer at a higher rate has driven the consumption.(Desai 1986) through a policy study for growth of consumption, it was opined that constraint in the lowering real price of fertilizer will determine the consumption. Further, he added that non-price factors such as improving the efficiency, shifting the response by improving the deficiency of supply and distribution system. (Ravinutala 2016) studied on the issues of plaguing the market for urea. It was found that about 22 per cent of subsidies accumulated by richer farmers and 36 per cent of the subsidized urea are lost through leakages in industries and smuggled across the borders.

Study by (Rama Rao et al. 1998) use pattern in different agro climatic zone in Andhra Pradesh, which found a wider variety of use within and across different agro-climatic zone. Secondary data also reflect that the use of fertilizer in the Krishna Godavari Basin, North Andhra Pradesh due to paddy cultivation, where irrigation as a relative factor for driving farmers' decision towards use. Although there was no correlation between irrigated and dry land crops. Demand side factors such as irrigated area and area under commercial crop and supply side factors influenced the behavior. Area under irrigation had a negative influence on the use of N fertilizer for dry land crops. In dry land farmers inclination was more to invest in crop where yield risk was low. (Mohanty 1998) explored that paddy yield in Sambalpur increases significantly with increasing levels of nitrogen taking in to observe the result of the soil test. 100 per cent dozes of nitrogen give 28 per cent increase in yield over the control group. But as it is evident that right doses of NPK are equally important, however, when full doses of Phosphorus yield increases by 30.55 per cent over the control group.

(Bezbaruah and Roy 2002)revealed from a study among small farmers in Barak Valley that the regression coefficient among operation holding, tenancy and low land were significantly positive. However the there was no significant variation in application of N fertilizer per hectare and multiple cropping, but it is found to significant only when per hectare availability of N fertilizer is conditional upon the availability of irrigation and extension services. (Indranil, Biswajit, and Sahu 2009)in a West Bengal among marginal and small farmers at farm level and regional level that in the deed knowledge gap insignificantly create a difference in nitrogen consumption. Knowledge gap creates a difference in appropriate application of N fertilizer.

Mala, 2013 reflected through her study that the use of N fertilizer is affected by various factors such as irrigation, high yielding variety and size of farm credit. As a result, it increased the quantity of production from the area under high yielding variety. Secondly the policy played an important role which provides impetus manufacturers to produce and distribute at a higher subsidy rate. Khajuria 2016in its study in Punjab had noted the wide consumption of nitrogen fertilizer has dropped the productivity of wheat due to low fertility of soil. The correlation between wheat yield and nitrate consumption has been very high value of 0.91. At an extreme, it has not only had a higher content of nitrate in wheat yield, but also ground water contamination which led to impure water quality in the state of Punjab.

Chakraborty 2016 noted through a simple linear regression model the relationship between determinants of demand and non-price factor, where it was found that non-price factors are more important than the price of fertilizer. The study recommended gearing upon government policies, the use of balanced nutrient and incentive manufacturers to produce environmentally sustainable products. Chadha and Meena 2019noted through regression analysis in three temporal phase i.e. Post green revolution phase1 (1967-1981), Post green revolution phase II (1981-1991) and post economic reform period (1991-2015). High coefficient of multiple determinations reflected that gross irrigated area highly influences the consumption in all the three phases. Followed by high yielding variety, but the coefficient of rainfall was found to be statistically non-significant in all three phases.

Geographical diversity with varied agro-climatic zones, irrigation intensity, size of operational holding and also cultivation practices makes agriculture in India different. Each state produces and contributes with it's at most utilization of both natural and man-made resources. Advent of green revolution, economic reforms, liberalizing policies on nutrient, especially fertilizer, the market system has been supporting backbone of Indian farmers, especially marginal and small farmers apart of all disparity and the challenges they face. However, there are studies on the factors determining the use of nitrogen fertilizer and also make it more challenged to study due to the trend of ineffective use, low nitrogen use efficiency and eco-environmental challenges it is facing up to. Various prices and non-price factors were taken into consideration over the period for studies, but few common factors such as a high yielding variety of seeds, area under irrigation were highly influenced in determining the use of nitrogen fertilizer. Secondly relative price i.e. ratio of price of nutrient to price of output, procurement cost, credit size were found to be significant. Post economic reforms factors such as rainfall, extension, technology were found to be significant, but not to a higher extent. Policy such as subsidy is a cross cutting factor which is relative to every factor and cannot alone influence the farmer to use. Education, years of experience in agriculture, the decision of the head of the family members were less significant.

Gap In Existing Body Of Literatures And Area Of Future Research

The existing literature has not emphasized on comparative studies between Nitrogen and Phosphorus & Potassium. On the economic front, the existing body of knowledge has not focused on estimating the cost of expenditure vs. Fair return (actual return) forms output, which could help in releasing economic stress of using high nitrogen fertilizer.

Environmental implication of nitrogen fertilizer by estimating composite environmental costs has not been emphasized. Though studies have focused on qualifying that there is environmental loss due to excessive and injudicious use, quantitative scale/method of estimating the composite cost of nitrogen use in different agricultural contexts has not been studied much.

Internal trade policy and subsidy has liberalized the consumption of N fertilizer and thereby increase in its use intensity. But the entire supply chain of fertilizer and its implications on marginal and small farmers have not been studied much with the perspective of ascertaining the drivers of N fertilizer use.

Conclusion

The use of nitrogen fertilizer is being seen as one of the necessary agricultural inputs to restore nutrient into the plants. The use of N fertilizer varies across context at farm as reported in different studies. Policy towards controlling the price of Urea as a 'straight nitrogen fertilizer' is highly skewed and low price brought an impetus to use nitrogen fertilizer. It has been seen that the intensity of nitrogen fertilizer use is higher among marginal and small farmers. However, they were highly vulnerable and plagued with low economic gains and high economic and environmental costs. Non-price factors such as high yielding variety, irrigation, relative price, procurement cost, credit size, and technology drive the farmers in making decisions towards using nitrogen fertilizer. Price factor such as price of output were also found to be significant only when relative price is affected. Increasing urea subsidy over the years puts fiscal pressure on government and environmental stress as well. The research gap, as mentioned in the previous section, is expected to provide a pathway towards future research in improving use efficiency of inputs including irrigation efficiency, narrow down the NPK ratio and judicious use of nitrogen fertilizer.

Acknowledgment

The authors acknowledge the valuable comments given by Prof. Tapan Adhya, Director, South Asia Nitrogen Centre, New Delhi, Co-Director (Science) UKRI-GCRF South Asia Nitrogen Hub& Professor, School of

Biotechnology, KIIT Deemed to be University. This paper results from research funded by UKRI under the title 'South Asian Nitrogen Hub [SANH]. The project team includes partners from across South Asia and the UK. Neither UKRI nor any of the partner institutions is responsible for views advanced here. The authors are responsible for the content of the paper.

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