Economic Affairs, Vol. 62, No. 4, pp. 1-5, December 2017
DOI:

Crop Response to the Application of NCU in Major *Kharif* Crops: An Impact Assessment in Central India

H.K. Niranjan*, D. Rathi, H.O. Sharma, R.S. Chouhan and S.S. Thakur

Agro-Economic Research Centre, Jawaharlal Nehru Krishi Viswavidyalaya, Jabalpur, Madhya Pradesh, India

*Corresponding author: niranjan86hemant@gmail.com

ABSTRACT

The study confined to two major *kharif* crops i.e. paddy and soybean of central India. A multistage stratified simple random sampling method was used to select the districts, blocks, villages and farm households, and to assess the impact of NCU over NU with respect to yield, cost of NCU over NU, other fertilizers use, cost of pest & diseases control and weed management. They were analysed using paired t-test and the cost of cultivation and partial budgeting technique. The impact of NCU was found to be highly significant in paddy and soybean when compared with NU in terms of yield of main and value of main and by product, while yield of by product in case of paddy and soybean was found to be significant. The cost of NCU fertilizer had reduced by 10.25% when compared to NU fertilizer, while the cost of weed management, pest & diseases control and other fertilizers were found to have increased by 13.44, 12.82 and 4.44% respectively in the cultivation of paddy. In case of soybean, the cost of NCU over NU, other fertilizers, and weed management was found to be reduced by 9.14, 9.20 & 1.68 respectively. The total cost of ₹ 1140/acre was added under different sub-head due to the application of NCU in paddy and soybean with added and net return of ₹ 3959 & ₹ 2819 and ₹ 2545 & ₹ 1405 per acre along with benefit cost ratio of 3.47 and 2.23 in case of paddy and soybean, respectively.

Keywords: NCU, Economic feasibility, Partial Budgeting Technique, Paddy, Soybean

Fertilizers in general and nitrogenous fertilizers in particular have made a major contribution towards the enhancement of agricultural productivity in the country. However, there is a continuous need to improve the efficiency of nitrogenous fertilizers in order to achieve more productivity of crops and to minimize the fertilizer related environmental problems. The results of several studies showed that only 50-60% nitrogen is usually recovered by crop plants, when nitrogen is applied through nitrogenous fertilizers. The recovery per cent of the applied nitrogen to rice is generally lower than fifty. There are a lot of differences in Neem Coated Urea (NCU) and the Normal Urea (NU). In NCU, a layer of *Neem*is seen over the plain urea that increases the soil fertility capacity and leads to higher production of crops. The oil coating of *Neem* in NCU mixes up slowly with the soil and the crop soaks it according to the need. The unwanted urea gets washed away with water or gets diluted in the air as nitrogen. Urea is the most common nitrogenous fertilizer used uniformly throughout the world. The wide acceptance of Urea is because of its agronomic acceptability and relatively lower cost when compared to the other fertilizers. Nitrogen application has both advantages and disadvantages. Advantages of Urea application are: (i) it is one of the primary/macro nutrients frequently required in a crop fertilization programme; (ii) Urea is a concentrated source of available nitrogen with a high nitrogen content of 46%; (iii) it increases vegetative growth and is necessary for the photosynthesis of plants. (iv) Besides being widely used as an excellent fertilizer for plant growth, it can also be used among a number of products such as animal feed, commercial products, glue, resin, cosmetics, pharmaceuticals, dish soaps, hair conditioners, tooth whiteners and so on. Disadvantages of Urea

application are: (i) Urea is easily soluble in water and decomposes even at room temperature that results in severe loss; (ii) it has adverse effect on seed germination, seedling growth, and early plant growth in soil (Bremner & Krogmeier, 1988); (iii) excess nitrogen which is not absorbed by the plants leach into the groundwater aquifers and rivers, enters human body as drinking water resulting in health disorders (Majumdar and Gupta, 2000); (iv) excessive air-and water-borne nitrogen from fertilizers may cause respiratory ailments, cardiac disease, and several cancers; (v) it can inhibit crop growth and affect the dynamics of several vector-borne diseases (Townsend *et al.* 2003).

Neem acts as a nitrification inhibitor and its coating over urea minimizes loss due to leaching. Coating urea with *neem* prevents its misuse as well as puts the fertilizer in slow release mode thereby nourishing the saplings for a longer period. Thus, avoids the repeated use of fertilizer and economizes the quantity of urea required by crops by enhancing Nitrogen-Use Efficiency (NUE)). Besides, coating of *neem* oil also reduces the leaching of nitrates into the groundwater aquifers and thus, helps in reducing its pollution. With this background, Government of India included *neem* coated urea (NCU), a slow release fertilizer in the Fertilizer (Control) Order, 1985 and made it mandatory for all the indigenous producers of urea to produce 100% of their total production of subsidized urea as NCU from 2015. Further, various steps have been taken to promote NCU, with a view to improve soil health status and also realise higher yield per hectare. With the introduction of NCU from 2015 and total replacement of normal Urea by NUC, it has become imperative to access the impact of Neem Coated Urea over Normal Urea in the production and yield of major crops in India. Looking at the present scenario, the present study has been undertaken to examine the coverage of NCU along with its impact on the yield of Paddy and Soybean in Madhya Pradesh and to analyze the impact of the adoption of NCU over NU on cost and profitability of paddy and soybean.

DATA BASE AND METHODOLOGY

The study confined to two major *kharif* crops i.e. paddy and soybean of Madhya Pradesh. A multistage stratified simple random sampling method was used to select the districts, blocks, villages and farm households. At the first stage, two districts having the highest area and highest consumption of NU/NCU have been selected for paddy and soybean. In the first stage, Balaghat & Seoni districts for paddy and Khargone and Dhar districts for soybean have been selected in Madhya Pradesh. In the second stage, two blocks were selected from each selected district. In this way Lalbarra & Kirnapur blocks from Balaghat district and Kewalari & Barghat blocks from Seoni district were selected for Paddy, whereas Maheshwar & Badwah blocks from Khargone, and Dhar & Badnawar blocks from Dhar district were selected for Soybean. From the selected blocks 2 cluster of villages comprising more than 4 villages per cluster were selected for the collection of primary data. A sample of 50 farmer from each block comprising 100 farmers in each district, totalling to 200 farmers to each crop were selected for the study. Thus, the study comprises of 400 respondents of two major kharif crops i.e. Paddy (200) and Soybean (200). Collected data were classified, tabulated and analysed using percentage and paired'*t*' *test* along with Partial budgeting technique used to analyse the impact of NCU over NU.

RESULTS AND DISCUSSION

The impact of the application of NCU over NU in terms of yield, cost of Urea/NCU, other fertilizers use, cost of pest & diseases control and weed management used was analysed by using the paired *t*-test and the impact on the cost of cultivation was analysed using the partial budgeting technique (return from investment) and benefit cost ratio. The impact of NCU over NU was analysed with respect to yield, the total fertilizers and the cost of cultivation by using NCU and NU data pertains to the year 2015 and 2014 respectively as NCU was not found to be applied during the year 2014 in the area under study.

Impact on yield of soybean and paddy

The impact of NCU over NU on the yield of paddy and soybean respondents was analysed by considering the quantity and the value of main and by products and is depicted in Table 1.

Table 1: Impact of NCU over NU on Yield of paddy and soybean among the sample Households

Particulars	NCU	NU	't' Value	% change in NCU over NU
Paddy (n=200/146)				
Main product Yield (kg)	1406	1206	6.48***	16.58
Value of Main product (₹)	19432	16333	7.02***	18.97
By produce on Yield (kg)	2369	2250	1.75*	5.29
Value of By product (₹)	3669	2700	9.15***	35.89
Soybean (n=200/108)				
Main product Yield (kg)	532	386	4.35***	37.82
Value of Main product (₹)	16763	13876	4.80***	20.81
By produce on Yield (kg)	798	718	2.97**	11.14
Value of By product (₹)	1430	1173	3.49***	21.91

****1, **5 & *10 % level of significance.*

Table 2: Impact of NCU over NU on Important Parameters of Input Cost in case of paddy and soybean growers

Particulars	NCU Mean	NU Mean	't' Value	% change in NCU over NU
Paddy				
Cost of NCU over NU	300	334	2.34**	-10.25
Cost of others Fertilizers	1309	1253	0.81	4.44
Cost of Pest and Disease Control	399	353	1.64	12.82
Cost of Weed Management	339	298	1.27	13.44
Total Cost	2347	2146	1.82	9.37
Soybean				
Cost of NCU over NU	118	130	1.73	-9.20
Cost of others Fertilizers	1229	1352	1.27	-9.14
Cost of Pest and Disease Control	220	184	1.22	19.92
Cost of Weed Management	414	421	0.17	-1.68
Total Cost	**1981**	**1872**	**1.38**	**5.82**

*** 5 % level of significance.*

It is clear from the data that out of 200 sample farmers, 146 and 108 respondents were found to apply NCU in the cultivation of paddy and soybean, respectively. The impact of the application of NCU over NU is reflected in terms of yield obtained by paddy and soybean growers, which had increased by 16.58 and 37.82% respectively. The impact of NCU was found to be highly significant in paddy and soybean when compared with NU in terms of the yield of main and value of main and by product, while the yield of by product in case of paddy and soybean was found to be significant.

Impact of NCU on important indicators of input cost

The Impact of NCU over NU on important indicators of input cost viz. cost of NU/NCU, other fertilizers, pest & diseases control and weed management was analysed for paddy and soybean growers and is presented in Table 2**.**

The analysis of the impact of NCU over NU on various input cost shows the significant reduction in the cost of NCU fertilizer and had reduced by 10.25% when compared to NU fertilizer, while the cost of weed management, pest & diseases control and other fertilizers were found to have increased by 13.44, 12.82 and 4.44% respectively in the cultivation of paddy. In case of soybean, the cost of NCU over NU, other fertilizers, and weed management was found to have reduced by 9.14, 9.20 & 1.68 respectively, while the cost of pest & disease control increased by 19.92%. Only the cost of NCU over NU had reduced and was significant in case of paddy, while the other input costs in case

of both the crops were found to be non-significant, which indicates that application of NCU in paddy leads to reduction in the cost of NCU fertilizers.

Economic feasibility of NCU over NU: A partial budgeting framework

The impact of NCU over NU on the cost of cultivation of paddy and soybean was analyzed using partial budgeting technique and the results obtained are presented in Table 3 and 4. The variables considered for estimating partial budgeting framework in the study included the cost of Seed, organic/FYM, NU/NCU, Chemical fertilizers (Other than Urea/NCU), plant protection chemicals, irrigation charges, labour charges and Miscellaneous charges.

The added cost & reduced return and reduced cost & added return due to the application of NCU in paddy were analysed and are presented in Table 3.

It is clear from the above table that the added cost due to NCU application amounted to ₹ 1140 per acre. The added cost was found to be maximum in case of labour (₹ 669/acre) followed by miscellaneous charges (₹ 251/acre), other chemical fertilizers (₹ 61/acre), seed (₹ 53/acre), NU/NCU (₹ 53/acre), plant protection chemical (₹ 43/acre) and organic manures/FYM (₹ 10/acre). Only the cost of irrigation reduced by ₹ 17/acre. Thus, the total cost of ₹ 1140/acre was added under different sub-head due to the application of NCU in paddy and the added return was found to be ₹ 3959/acre. Hence, net return due to the application of NCU in paddy was found to be ₹ 2819/acre with benefit cost ratio of 3.47.

The added cost & reduced return and reduced cost & added return due to the application of NCU in the cultivation of soybean were analysed and presented in Table 4.

The results obtained in the above table clearly indicates that the added cost was amounted to ₹ 1140 with the reduced cost of irrigation by ₹ 27/acre. The maximum cost was incurred in case of labour (₹ 545) followed by seed (₹ 339), plant protection chemical (₹ 48), miscellaneous charges (₹ 163), NU/NCU (₹ 27), irrigation (₹ 9) and organic manures (₹ 9) per acre. Thus, the total cost under different sub-head due to the application of NCU amounted to ₹ 1140/acre with the added return of ₹ 2545/acre. Hence, net return and B: C ratio due to the application

Table 3: Economic feasibility of NCU in Paddy, using partial budgeting Framework (₹ /acre)

A			B		
Sl. No.	**Added cost due to NCU**	**Costs**	**Sl. No.**	**Reduced cost due to NCU**	**Returns**
1	Seed cost/ purchase of seedlings	53	1	Seed cost/ purchase of seedlings	0
2	Organic/FYM	10	2	Organic/FYM	0
3	Urea/NCU	53	3	Urea/NCU	0
4	Chemical fertilizers (Other than Urea/NCU)	61	4	Other Chemical fertilizers	0
5	Plant protection chemicals	43	5	Plant protection chemicals	0
6	Irrigation charges	0	6	Irrigation charges	17
7	labour charges	669	7	Labour cost	0
8	Miscellaneous charges	251	8	Maintenance costs	0
	Total Added Cost	**1140**		**Total Reduced Cost**	**17**
Sl. No.	**Reduced Return due to NCU**	**Costs**	**Sl. No.**	**Added Return due to NCU**	**Return**
1	Main product	0	1	Main product	3109
2	By-product yield	0	2	By-product yield	833
	Total of reduced return	0		Total Added Returns	3942
	Total "A" (Additional Cost)	1140		Total "B" (Additional Return)	3959
	Additional Return from NCU (Total B-Total A)	2819			
	Benefit Cost Ratio (Total B/Total A)	3.47			

Table 4: Economic feasibility of NCU in Soybean, using partial budgeting Framework (₹ /acre)

A			B		
Sl. No.	**Added cost due to NCU**	**Costs**	**Sl. No.**	**Reduced cost due to NCU**	**Return**
1	Seed cost/ purchase of seedlings	339	1	Seed cost/ purchase of seedlings	0
2	Organic/FYM	9	2	Organic/FYM	0
3	Urea/NCU	27	3	Urea/NCU	0
4	Chemical fertilizers (Other than Urea/NCU)	0	4	Other Chemical fertilizers	27
5	Plant protection chemicals	48	5	Plant protection chemicals	0
6	Irrigation charges	9	6	Irrigation charges	0
7	labour charges	545	7	Labour cost	0
8	Miscellaneous charges	163	8	Maintenance costs	0
	Total Added Cost	**1140**		**Total Reduced Cost**	**27**
Sl. No.	**Reduced Return due to NCU**	**Costs**	**Sl. No.**	**Added Return due to NCU**	**Return**
1	Main product	0	1	Main product	2111
2	By-product yield	0	2	By-product yield	407
	Total of reduced return	0		Total Added Returns	2518
	Total "A" (Additional Cost)	1140		Total "B" (Additional Return)	2545
	Additional Return from NCU (Total B-Total A)	1405			
	Benefit Cost Ratio (Total B/Total A)	2.23			

of NCU in soybean were found to be ₹ 1405/ acre and 2.23 respectively.

CONCLUSION

This clearly indicates that the farmer will be in advantageous position by applying NCU in their fields and will be able to harvest more profit by cultivating paddy over soybean as far as major *kharif* crops in central India is concerned. The impact of NCU was found to be highly significant in paddy and soybean when compared with NU in terms of the yield of main and value of main and by product, while yield of by product in case of paddy and soybean was found to be significant. Only the cost of NCU over NU had reduced and was found significant in case of paddy, while other inputs cost in case of both the crops were found to be non-significant, which indicates that the application of NCU in paddy leads to reduction in the cost of NCU fertilizers. Based on the results it can be suggested that the complete package of practices with NCU for both crops for different regions should be made available to the farming community at the earliest for harnessing the potential of the technology in a fullest manner.

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