# Use and effectiveness of neem coated urea: A pan-India exploration

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#### ABSTRACT

It has become mandatory for all the domestic producers of urea to produce Neem Coated Urea (NCU) since 2015 to reduce overall input cost in farming and to ensure environmental sustainability through enhanced nitrogen use efficiency (NUE). The present study was carried out during 2017–19 with the aim to find out the awareness level of farmers about NCU and its impact on crop productivity. A total of 12,604 farmers across the country were interviewed by 458 Krishi Vigyan Kendras (KVKs). The results of the study showed that 76% farmers were aware about NCU and its effectiveness in increasing crop yield. Farmers of Delhi NCR, Haryana and Rajasthan were found to have the highest awareness while those of Arunachal Pradesh, Sikkim, and Jammu & Kashmir had the lowest level of awareness. Overall, 79% farmers were satisfied with its use. Use of N fertilizers decreased significantly in 2018 compared to 2017 in both the seasons (*kharif* and *rabi*), however, the existing rate of application was still significantly higher than recommended doses. The average yield enhancement due to use of NCU was 8.25%. The highest yield increase due to use of NCU was observed in Goa, Madhya Pradesh, and Andaman & Nicobar Islands. Results of the study implied that more emphasis is needed for dissemination of information about NCU through awareness, training and capacity building programmes for farmers and grassroots level extension functionaries.

**Keywords**: Crop yield, Environmental sustainability, Neem coated urea (NCU), Nitrogen use efficiency (NUE), Nitrogenous fertilizer

Application of fertilizers at higher than recommended dose is a common trend among semiliterate and illiterate Indian farmers, which not only hampers the environment but also takes a toll on cost of cultivation causing lesser economic return to the farmers. The Government of India chalked out alternative fertilizer use mechanisms in recent times, one of such measures being mandatory diffusion of NCU since 2015. More than 20 MT of urea alone is used in the country (Babu 2014). The continued efforts of researchers have led to the development of NCU which helps increase NUE in crops (Ramappa and Manjunatha 2017). Benefits of NCU include slowing down the process of nitrification of urea, enhancing yield, decreasing urea requirement, reduction in environmental pollution of groundwater due

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to leaching of nitrates and gaseous emissions etc. Saving 10% of losses of urea would amount to 2 MT of urea or a reduction in subsidy component to the tune of  $\Box 1,700$  crores per annum. It can also open up new avenues for entrepreneurs to commercialize local Neem and form small scale Industries in rural areas (Babu 2014).

The Government of India decided, in January 2015, to make it mandatory for the indigenous Urea producers to produce a minimum of 75% NCU, out of the total domestic production. This cap was then raised to 100% from May 2015 onwards. This has been done with aim to increase efficiency of urea fertilizer, benefit farmers by lowering cost of cultivation, stop diversion of urea for other industrial use and maintain soil health through judicious use of nitrogenous fertilizers. In order to ensure balanced use of fertilizers and reduce the consumption of urea, the Government of India decided to introduce 45 kg bags of urea in place of 50 kg bags. In this backdrop, the present study was conducted across the country to find out the impact of NCU on crop productivity and awareness of farmers regarding its use.

### MATERIALS AND METHODS

Locale of the present study covered 32 states and Union Territories (UTs) of India. A total of 12,604 farmers,

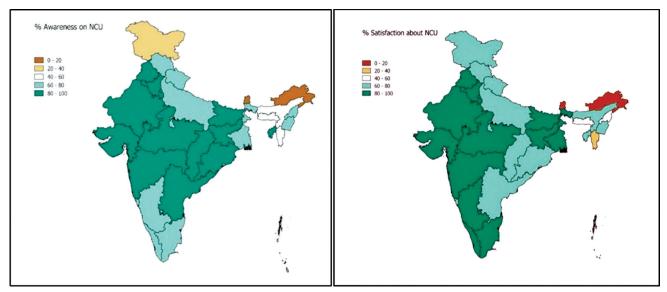


Fig 1 Awareness and satisfaction level of state farmers about NCU and its use.

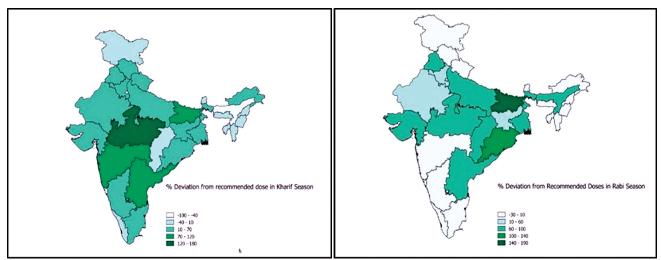


Fig 2 Thematic distribution of states based on percent deviation from recommended doses of use in kharif and rabi season.

randomly selected, constituted the sample of the study. The entire assessment is based upon analysis of cross sectional primary data pertaining to the period from kharif 2017 to rabi 2018–19, generated through personal interview method with the help of a structured and pretested personal interview schedule conducted by 458 KVKs. The major focus of the study was to find out statewise variations (if any) in awareness, satisfaction and practice of farmers regarding N-fertilizer use through NCU. Statewise variations in N fertilizer use through 45 kg bags of NCU were worked out. Seasonwise [kharif (2017 and 2018) and rabi (2017–18 and 2018–19)] deviations in average application of N-fertilizer through NCU, were also calculated in course of the study. Further, deviations in application (if any) of N-fertilizer through NCU against the recommended doses of use was studied. Statewise differential yield increase of different crops as a result of NCU application was also worked out. Suitable statistical tools and techniques were applied to analyze the data using the software SPSS 19.0. Choropleth maps were developed using the software QGIS 2.18.14 for

comprehensive visualization of statewise differences in the parameters under study.

## RESULTS AND DISCUSSION

Awareness and Satisfaction of farmers in use of NCU: Awareness studies play crucial role in enriching understanding about the awareness-decision paradoxes and their determinants (Paul et al. 2017). A better awareness is an indication of progressiveness (Kumar et al. 2015). Results of the present study show that about 76% farmers were aware about the use and effectiveness of NCU in augmenting crop yield. Two thematic maps (Fig 1, 2) have been produced to picturize the distribution of states based on the extent of awareness and satisfaction of state farmers in use of NCU, especially with 45 kg bags. About 69% farmers were found to be aware about 45 kg bags of NCU. Farmers of Delhi NCR were found to have the highest level (100%) of awareness, followed by Haryana (97.5%) and Rajasthan (93.38%) whereas, farmers of Jammu & Kashmir had the lowest level of awareness (38.04%). Overall, 79% of the

Table 1 Farmers with differential level of fertilizer application during 2018–19 compared to 2017–18 (i.e. year of introduction of 45 kg NCU bags)

State	Frequency and Percentage of farmers using different levels of urea in <i>kharif</i> and <i>rabi</i> 2018 compared to <i>kharif</i> and <i>rabi</i> 2017				
	Same	Higher	Lower		
A & N Islands	26 (65.00)	8 (20.00)	6 (15.00)		
Andhra Pradesh	609 (59.71)	139 (13.63)	272 (26.67)		
Assam	414 (40.19)	273 (26.50)	343 (33.30)		
Bihar	314 (60.38)	66 (12.69)	140 (26.92)		
Chhattisgarh	489 (52.02)	134 (14.26)	317 (33.72)		
Delhi	40 (100.00)	0 (0.00)	0 (0.00)		
Gujarat	607 (49.19)	133 (10.78)	494 (40.03)		
Goa	36 (64.29)	0 (0.00)	20 (35.71)		
Haryana	394 (54.72)	0 (0.00)	326 (45.28)		
Himachal Pradesh	255(63.91)	55 (13.78)	89 (22.31)		
Jammu & Kashmir	347 (49.08)	82 (11.60)	278 (39.32)		
Jharkhand	162 (45.00)	33 (9.17)	165 (45.83)		
Karnataka	230 (39.86)	63 (10.92)	284 (49.22)		
Kerala	61 (38.13)	40 (25.00)	59 (36.88)		
Manipur	64 (30.19)	51 (24.06)	97 (45.75)		
Maharashtra	839 (47.51)	247 (13.99)	680 (38.51)		
Madhya Pradesh	983 (49.47)	386 (19.43)	618 (31.10)		
Meghalaya	32 (40.00)	6 (7.50)	42 (52.50)		
Mizoram	12 (30.00)	26 (65.00)	2 (5.00)		
Nagaland	36 (30.00)	9 (7.50)	75 (62.50)		
Odisha	491 (49.10)	202 (20.20)	307 (30.70)		
Puducherry	62 (77.50)	0 (0.00)	18 (22.50)		
Punjab	140 (14.61)	43 (4.49)	775 (80.90)		
Rajasthan	1407 (80.40)	41 (2.34)	302 (17.26)		
Tripura	8 (20.00)	28 (70.00)	4 (10.00)		
Tamil Nadu	417 (50.24)	95 (11.45)	318 (38.31)		
Telangana	271 (43.15)	127 (20.22)	230 (36.62)		
Uttar Pradesh	2478 (37.53)	1742 (26.39)	2382 (36.08)		
Uttarakhand	272 (67.66)	25 (6.22)	105 (26.12)		
West Bengal	238 (38.39)	149 (24.03)	233 (37.58)		

Figure in parentheses represent percentage.

farmers were satisfied with its use. Farmers of Delhi NCR (100%), Haryana (96.67%) and Bihar (92.92%) reported the highest level of satisfaction. The lowest level of satisfaction could be noticed for the farmers of the Northeastern states of Meghalaya (50%), Nagaland (46.67%) and Mizoram (40%). A positive and significant association was noticed between overall awareness about NCU and the specific awareness about 45 kg bags of NCU (r=0.82, P=0.000). A positive and significant association could also be noticed between awareness and satisfaction (r=0.91, P=0.000). There was a significant increase in the application of NCU after 2015-16 in crops like paddy, wheat, sugarcane, potato, maize, sunflower and vegetables. Earlier studies have also reported high level of awareness of farmers regarding availability of NCU in the market, although a majority of them were not aware of the potential benefits of using NCU (Ramappa and Manjunatha 2017). In all the studies, it is found that the main sources of information on NCU are the Departments of agriculture, input suppliers, fellow farmers and cooperative societies.

Reduction in application of N fertilizer with use of 45 kg bags of NCU: As high as 34% of the farmers stated that they used lesser amount of urea in kharif 2018 as compared to kharif 2017. The finding is quite significant and encouraging as it implied that within one year of introduction of 45 kg bags, usage could be curbed at least by one-third of the users. Whereas, 49% farmers reported to use the same amount of urea, only 17% reported to use higher amount during kharif 2018. In rabi 2018, 37% farmers reported to have applied lesser amount of urea than rabi 2017. About 44% farmers were using the same level of urea, and the remaining 16% were still using it at a higher rate in the rabi season. The highest number of farmers adopting curtailed use were noticed in Punjab (80.90%), followed by Nagaland (62.50%) and Meghalaya (52.50%) (Table 1). It may be due to the fact that over the years, the farmers in Punjab have become much more aware and cautious of the detrimental effects leading to several deadly health and environmental hazards due to indiscriminate use of chemical inputs in crop farming in the state (Mittal et al. 2013). Previous studies also reported that awareness among farmers in Punjab about NCU is quite high (Grover et al. 2016). The farmers in the Northeastern states are traditionally low chemical input users as they subscribe to the intricacies of nature positive systems of farming (Ray et al. 2020; Paul et al. 2020, 2015). The traditional indifference of the farmers of Nagaland and Meghalaya towards chemical fertilizers might have also helped in reduction of urea use in the states.

Table 2 Per cent decrease in average application of N-fertilizer through NCU in major kharif and rabi crops

Season	Crop	Average application	Average application	%	State with highest change	State with lowest change
		in 2017	in 2018	decrease		
Kharif	Paddy	187.3704	177.6833	5.17	Gujarat (70.9%)	Karnataka (-218.24%)
	Maize	216.5	227.7	-5.17	Jammu & Kashmir (24.05%)	Bihar (-167.81%)
Rabi	Wheat	178.1786	154.6393	13.21	Chhatiisgarh (21.07%)	West Bengal (6.04%)
	Potato	273.3462	252.9346	7.47	Odisha (35.83)	Tripura (-10%)

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Crop	Difference between 2017 and 2018		Difference between 2017 and recommended dose		Difference between 2018 and recommended dose	
	Test statistics	P-value	Test statistics	P-value	Test statistics	P-value
Kharif						
Paddy	1.475	0.154	6.663	0.000*	5.73	0.000*
Maize	0.285	0.780	4.082	0.001*	4.092	0.001*
Total	4.845	0.000*	5.267	0.000*	4.457	0.000*
Rabi						
Wheat	-0.285	0.780	4.082	0.001*	4.092	0.001*
Potato	1.625	0.135	4.935	0.001*	4.404	0.001*
Total	4.141	0.000*	9.018	0.000*	7.752	0.000*

Crop wise decrease in N fertilizer use was also investigated for four major crops of *kharif* and *rabi* seasons (Table 2). In case of paddy, there was a reduction of around 5% in average application of N fertilizer during 2018 when compared to 2017 with the highest decrease noticed in Gujarat (70.90%). In case of maize, the average application of N fertilizer increased by around 5% with the highest increase noticed in Bihar (-167.81%). The highest decrease in N fertilizer use in maize was noticed in the state of Jammu and Kashmir (24.05%). In case of *rabi* crops, for wheat around 13% decrease was noticed in average application across states, with the highest decrease recorded in Chhatisgarh (21.07%). For potato, around 7.5% decrease in average N fertilizer application was worked out with the highest decrease in the state of Odisha (35.83%).

An attempt was also made to investigate if the differences in fertilizer application were statistically significant in some of the major crops using paired sample t-test. It was found that overall significant difference existed in fertilizer application between 2017–18 and 2018–19 for both *kharif* and *rabi* crops. However, for none of the crops under study (paddy, maize, wheat and potato) significant difference in N-fertilizer use could be noticed. This could be due to smaller sample size of the data for crops. Despite overall decrease in N-fertilizer application; there still existed significant differences with the recommended doses for all the four crops in both the seasons and also for overall dataset of India (Table 3).

The average per cent deviation of the states from the recommended doses for *kharif* and *rabi* 2018–19 is presented in Fig 2. The highest deviation in *kharif* was found for the state of Madhya Pradesh while for *rabi* season, the highest deviation was noticed for the state of Bihar. Negative deviations were noticed in Assam in *kharif*, i.e. in the range of -100% to -49.93%. In case of *rabi*, negative deviations were noticed in Jammu and Kashmir, Uttarakhand, Karnataka, Goa and Tamil Nadu indicating that these states were using N fertilizer lesser than recommended doses.

*Impact on Yield*: Economic motivation of farmers is strongly based upon crop yield which is largely perceived by the farmers to be proportionately related with input use

(Roy Burman *et al.* 2020; Som *et al.* 2019). In the present study, it was found that the average yield enhancement due to use of NCU was 8.25% overall India. The highest yield increase due to use of NCU was observed in the states of Goa, Madhya Pradesh and Andaman and Nicober islands. Rajasthan, Haryana, Chandigarh, Delhi NCR, Bihar, Jharkhand, Sikkim, Meghalaya, Arunachal Pradesh had fallen in the lowest range of yield increase (0 to 4%) probably due to reduced soil fertility, faulty package of practices or already recorded higher levels of yields used as benchmark.

In a field experiment carried out during the kharif season in the research farm of the Indira Gandhi Agricultural University, Raipur, Chhattisgarh, it was found that in Vertisol, NCU performed significantly better than the other treatments for almost all the agronomic yield attributing characters of rice (Khandey et al. 2017). Neem coated urea increased the growth and yield, plant height, number of tillers/m, numbers of panicle/hill, numbers of grains/panicle in rice (Kumar et al. 2015). In a field experiment conducted during the kharif 2015 at Shivamogga in Karnataka, it was found that application of NCU resulted in significantly higher grain and better yield in maize resulting in higher net returns and B:C ratios (Shilpha et al. 2018). Results indicated that urea dose can be reduced by 50 kg/ha with marginal, non-significant reduction in yield when NCU was used.

The present study suggests that awareness of farmers regarding use and perception of effectiveness of NCU is quite encouraging. The average yield enhancement due to use of NCU was 8.25% for India. Significant decrease in use of N fertilizer was noticed in both *rabi* and *kharif* seasons from 2017–18 to 2018–19 crop seasons. However, there still existed significant differences between the recommended quantities and the quantities applied by the farmers. In most of the cases, farmers were using higher doses than what is recommended. Therefore, more emphasis must be given on dissemination of knowledge and information about the benefits of using NCU at recommended doses through awareness campaigns, training and capacity building programmes, farm literature, mass media and other modes of technology transfer.

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