

EXECUTIVE SUMMARY

Coating of urea prills with neem oil has proved increase in crop yields and thus, the National Fertilizer Ltd. adopted this technology at their plants and has started commercial production of NCU since July, 2004. Further, the Ministry of Chemicals and Fertilizers, Government of India has made it mandatory (vide its notification No. 12012/20/2007-FPP dated 25/05/2015) for urea manufacturers of the country to produce only NCU from May 2015, from 35 per cent in 2004 and then to 75 per cent in March 2015, and also permitted to sell NCU at 5 per cent higher the MRP as a part of meeting the cost of neem coating since 2008. The policy for encouraging production and availability of fortified and coated urea in the country is mainly aimed at controlling the excessive use of urea, which is deteriorating the soil health and thereby negatively affecting yields of crops. On the other hand, the Central and State Governments have been implemented several programmes on improving the soil health. Of them, the recent one is Soil Health Card (SHC) scheme, launched on 19th February, 2015 by the Government of India. The scheme is mainly aimed to promote soil test based balanced use of fertilizers. It was introduced to assist state governments to issue SHCs to all farmers in the country, which supplements the on-going scheme to create/strengthen capacity in terms of rapid and low-cost diagnostic techniques, mobile laboratories, portable soil testing kits and referral labs. Soil status will be assessed regularly every 3 years, so that nutrient deficiencies are identified and amendments applied. It is in this backdrop, it was necessary to assess the impact of NCU on production, productivity and soil health with a view to improving the efficiency in implementation of these interventions (NCU & SHCs scheme). Thus, the Department of Fertilizers (DOF) and its own INM (Integrated Nutrient Management) Division of Ministry of Agriculture and Farmers Welfare assigned the study to six Agro-Economic Research Centres/Units for undertaking the same in their respective states under the co-ordination of the Agricultural Development and Rural Transformation Centre (ADRTC) of the Institute for Social and Economic Change (ISEC), Bengaluru (Karnataka). Accordingly, the Agro-Economic Research Centre for Bihar & Jharkhand, T M Bhagalpur University, Bhagalpur (Bihar) has undertaken this study in Bihar with following objectives:

- *To analyze the trends in usage and prices of urea vis-à-vis NCU in the selected states.*
- *To analyze the adoption behavior of NCU among the selected farmers in irrigated and un-irrigated tracts.*
- *To analyze the impact of adoption of NCU on crop productivity and farmer's income.*
- *To document the status and implementation of Soil Health Card Scheme.*
- *To suggest suitable policy measures for adoption of NCU and implementation of SHCs scheme.*

In order to pursue the objectives of the study, both primary and secondary data were collected from four districts of Bihar namely; Rohtas, West Champaran, Begusarai and Bhagalpur. Both irrigated (paddy) and un-irrigated (maize) crops with highest usage of urea in the state were selected for the study. The reference period for collection of primary data was kharif, 2015. Primary data were collected from 200 farm households for each of the selected crops, totalling to 400 farm households in the state. The sample is consisted of 74.25 per cent (297 Hhs) marginal & small farmers, 14.50 per cent (58 Hhs) medium farmers and 11.25 per cent (45 Hhs) large farmers.

The findings and policy suggestions are presented as follows:

- Consumption of urea has substantially increased by 64.56 per cent during the last one decade. It constitutes around 54 per cent of total fertilizer consumption during triennium average of (TA) of 2003-04 to 2005-06, which came down to 48.77 per cent of total fertilizer consumption during TA of 2012-13 to 2014-15. It was higher during the rabi season (52 to 57%) compared to the kharif season (43 to 48%). The rate of consumption of total fertilizers registered an increase of 63 per cent (from 100.00 kg/ha in TA 2004-06 to 164.93 kg/ha in TA 2013-15). The prices of NU and NCU were almost stagnant at around Rs. 282/bag and Rs. 295 to Rs. 298 per bag respectively during last five years. Out of the total availability of NCU during kharif 2015, the data for its month wise distribution across the districts revealed that it was highest in the month of September (24.24%) followed by August (19.34%), June (17.37%), July (15.03%), May (12.69%) and April (12.96%). It was 44 per cent of the total transit alone during August and September, mainly due to growing stages of paddy crop.
- Net-operated area of total farms at overall level was estimated at 5.23 acres. It was 2.64 acres for marginal and small farmers, 8.60 acres for medium farmers and as high as 18.03 acres for large farmers at overall level. Data on irrigational status revealed that about 66.43 per cent of NOA were irrigated and 33.67 per cent un-irrigated on total farms at overall level. A wide gap in irrigational status between the crops was also noticed, which is quite natural because selected crops belonged to two different regions, such as irrigated and un-irrigated.
- Cropping pattern of paddy respondents indicates that they only grew paddy during kharif season. Out of the total sown area, paddy was grown in 54.49 per cent by large farmers, 26.93 per cent by medium farmers and 18.58 per cent by marginal & small farmers. More than 95 per cent of the total net sown area of paddy respondents was found irrigated. The cropping pattern of maize respondents reveals that they grew paddy, maize and soyabean during kharif season. About 60 per cent of the total sown area was devoted for paddy, 25 per cent for maize and 15 per cent for soyabean cultivation. More than 75 per cent of total net sown area of maize respondents was under rainfed cultivation.
- Major sources of irrigation was noticed, viz., bore well (79%) at overall farms' level followed by canal (27.50%) and open/dug well (8.50%). Bore wells were again major sources of irrigation for paddy respondents (63.50%) and maize respondents (94.50%). However, 55 per cent of paddy respondents reported about canal to be one of the important sources of irrigation.
- The purchasing pattern of NCU & NU reveals that NCU was purchased in larger quantity (310.62 kg/household) as compared to 131.35 kg/household at overall farms. It accounted for 70.28 per cent for NCU and 29.72 per cent for NU. In case of paddy, it was 469.15 kg/household (78.87%) and 125.66 kg/household (21.13%) for NCU & NU respectively. Similarly, in case of maize, it was 104.66 kg/household (43.64%) for NCU and 135.19 kg/household (56.36%) for NCU.
- Total paid-out costs borne by paddy respondents at total farms' level was Rs. 11086.29 per acre during 2014, which increased to Rs. 12009.48 per acre during 2015 registering an increase of about 8.33 per cent in 2015 over 2014. The gross and net returns realized by paddy respondents were calculated at Rs. 28042.22 per acre and Rs. 16955.93 per acre respectively at total farms during 2014, which increased to Rs. 29739.84 per acre and Rs. 17730.36 per acre respectively during 2015; indicating an increase of 6.05 per cent in gross returns and net-returns of 4.57 per cent in 2015 over 2014. The increase in both the returns may be due to increase in yield in 2015 over 2014.

- Similarly, total paid-out costs incurred by maize respondents at total farms was estimated at Rs. 13203.13 per acre during 2014, which came down to Rs. 12311.69 per acre during 2015, registering a decrease of 6.75 per cent in 2015 over 2014. The gross and net returns realized by maize respondents were estimated at Rs. 27012.14 per acre and Rs. 13809.01 per acre respectively at total farms' level during 2014, which increased to Rs. 29421.22 per acre and Rs. 17109.53 per acre respectively during 2015, registering an increase of 8.92 per cent in gross returns and net returns of 23.90 per cent. It is probably due to increase in yield by over 5 per cent in 2015 over 2014 on total farms.
- Total paid-out costs incurred by overall respondents at total farms was calculated at Rs. 11326.56 per acre during 2014, which increased to Rs. 12044.69 per acre during 2015, registering an increase of about 6.34 per cent. The gross and net returns realized by overall farmers were estimated at Rs. 27924.68 per acre and Rs. 16598.12 per acre respectively at total farms during 2014, which increased to Rs. 29702.72 per acre and Rs. 17658.03 per acre respectively during 2015; indicating an increase of 6.37 per cent in gross returns and net returns of 6.39 per cent in 2015 over 2014. The increase in paid-out costs and gross and net returns were largely due to increase in yields of both the crops.
- About 14.75 per cent of the overall farmers had taken loan. The average amount of borrowing at overall farms' level was about Rs. 2444. Of the total borrowings, nearly 83 per cent were from the institutional sources and remaining 17 per cent from non-institutional sources. It is noticed that institutional sources of borrowings played a significant role in providing credit to the overall farmers during the reference period.
- None of the sample farmers attended training programme meant for fertilizer application mainly because of non-specific training schedule.
- All sample farmers were aware of NCU across the farm sizes and reference crops as well. As regards the source of information, input shops/dealers were the major source in case of marginal & small farmers (89.23%), medium farmers (94.83%) and large farmers (86.67%) at overall crops' level. The second and third important sources were fellow farmers and print & visual media across the farm sizes at overall level. Almost same trend was noticed in case of paddy and maize farmers irrespective of farm sizes.
- About 90 per cent to 93 per cent of the overall farmers were able to differentiate NCU and NU across the farm at overall level. The major factor, which made them able to differentiate NCU over NU was smell (50% to 90%) across the farm sizes at overall crops' level. Almost similar factor was noticed in paddy and maize crops.
- Before 2015-16, 74.50 per cent of paddy farmers and 26.50 per cent of maize farmers applied NCU, whereas it was 82.50 per cent and 74 per cent respectively after 2015-16.
- Of the total quantity used, 41 per cent of NCU and 46 per cent of NU were used at vegetative growth stage followed by after weeding (31% to 35%) and 24 per cent to 28 per cent during Basel application stage at the overall crops' level.

- About 73 per cent to 92 per cent of NCU/NU was applied through broadcasting method and 8 per cent to 27 per cent by fertigation method at overall crops' level. In case of paddy, 100 per cent of the total quantity was applied through broadcasting method.
- As regards farmers' perception about NCU vis-à-vis NU 74.75 per cent of farm households at overall crops' level have mentioned that quality of NCU was good. About 81 per cent farmers at overall crops level reported adequate availability, 80.25 per cent told about timely availability and 58 per cent viewed the prices not to be very high. Nearly 59.75 per cent of the surveyed farmers at overall crops' level were benefitted from NCU in terms of decrease in total fertilizers usage. About 61.25 per cent reported for no change in the benefits of NCU in terms of urea usage. Decrease in pest and disease attack was noticed by 78 per cent of the sample households at overall crops level and 78.25 per cent reported about its (NCU) accessibility in the market compared to NU.
- The analysis of comparative benefits of NCU over NU revealed that 27.50 per cent paddy farmers had the advantage of 7.74 per cent yield increase. About 23.50 per cent told that benefit in weed management was also noticed to the extent of 7.99 per cent. The cost of NCU compared to urea was found to have increased to the extent of 12.64 per cent by 33 per cent of paddy farmers. Increase in cost of other fertilizer (9.09%) was also noticed by 22.50 per cent paddy farmers. About 90 per cent to 93 per cent of paddy farmers reported no change in soil health, quality and market acceptability of grain. In case of maize farmers, 18 per cent reported increase in yield to the extent of 6.89 per cent, 27.50 per cent found decrease in cost of pest and disease control to the extent of 12.71 per cent, 85 per cent reported no change in weed management, 25 per cent noticed increase in NCU cost as compared to urea to the extent of 11.52 per cent and 90 per cent to 96 per cent indicated no change in cost of other fertilizers, improvement in soil health, quality and market acceptability of grain.
- Analysis of constraints faced in course of adoption of NCU fertilizer revealed lack of training for crop wise application of NCU (43.50%) followed by lack of irrigational facilities (39.25%), lack of fertilizers retail shops in nearby areas (26%), lack of awareness about the benefits of NCU (22.25%), lack of fertilizer and water testing laboratories (10.50%) etc.
- Major suggestions for improving the NCU fertilizers' usage include crop wise/season wise training (58.75%), availability of fertilizers at village or panchayat level (42.75%), awareness campaign relating to benefits of NCU usage (34%), ensuring demand based supply of NCU (18.25%) etc.
- The performance of SHC scheme in the state reveals that 61.80 per cent of the target was achieved in terms of soil sample collection, but the achievement level was 59.45 per cent. On an average, five cards were printed per sample grid and all were distributed.
- Major sources of information about soil testing and soil sample collection were KVKs, neighbours and state department of agriculture as reported by about 67, 31 and 23 per cent of the sample households respectively at overall crops' level. Education on proper method of soil testing was largely extended by Kisan Salahkaars (64.10%) followed by farmers' themselves (35.90%).
- Out of the total sample, only 39 farmers (9.75%) got their soil-tested consisting of 20 farmers (10%) among paddy farmers and 19 (9.50%) maize farmers. Of the soil tested farmers at overall crops' level, 77 per cent were aware of appropriate method of soil sampling. Kisan Salahkaars of

the state department of agriculture (56.41%) was the major source of education for soil sample collection. All the soil tested farmers had received the SHCs. About 31 soil tested farmers were able to understand the information given in SHCs at the overall crops' level. Kisan Salahkaars (71.79%) was the major player, who rendered their services in educating about SHCs.

- The reason for soil testing narrated by the respondents was mainly to understand fertilizer requirement for the crop (66.67%) and the major reasons for not testing soil were unawareness about the method of soil sample collection (86.43%), distantly located STLs (81.71%) and not knowing the contact person (76.73%) at overall crops' level.
- Major problems faced in soil testing by the sample farmers were related to non-distribution of SHCs (34.50%), no collection of sample from individual farmers (33%), lack of STLs in hereby areas (23.75%), chargeable soil testing (23.50%) etc.
- To improve the SHC scheme, the major suggestions extended were organization of soil testing camp at village level (37%), prompt distribution of SHCs (37.25%), ensuring farmers' participation (34.50%), distribution of SHGs in hard copy in place of electronic communication (28.50%) etc.
- There had been a positive impact on yields of both the main and by-products of paddy and maize crops. The average yield of paddy, in which NCU was applied, is calculated at 26.82 quintals per acre as compared to those who used NU (24.51 qtls/acre), thus accounting for increase of 9.42 per cent in yield. Percentage change in yield of by-product was estimated at 7.60 per cent for NCU applicators over NU applicators. Similarly, the average yield of maize in case of those sample farmers, who applied NCU was calculated at 25.25 qtls per acre as compared to those used NU (23.38 qtls/acre). The percentage change in yield (main product) due to application of NCU was 7.99 per cent. The percentage change in yield of by-product was, however, 0.06 per cent only.
- Percentage change in comparative use of NCU vis-à-vis NU at overall crops' level was calculated at 0.22 per cent, which were (-) 8.42 per cent for paddy and 217 per cent for maize crops in 2015 over 2014. In case of NU, the same were (-) 25.51 per cent at overall crop level, (-) 5.37 per cent for paddy and (-) 45.89 per cent for maize crop. The productivity of NCU was found to have increased by 1.79 per cent, 1.97 per cent and 2.72 per cent for overall crops, paddy & maize crop respectively during 2015 over 2014. Similarly, the productivity of NU was found to have increased by 0.16 per cent for overall crop and 0.45 per cent for paddy during 2015 over 2014. However, a decrease of 0.12 per cent was found in case of maize crop in 2015 over 2014. Output per unit of NCU/NU was found at 5.89 at overall crop and 0.42 and 5.30 per cent at paddy & maize crops respectively.
- The qualitative benefits obtained from NCU was largely reported by no change for paddy crop (87% to 93%) and 91 per cent to 97 per cent for maize crop.
- Analysis of impact of NCU on input cost of paddy reveals that the cost of pest & disease control reduced by 5.29 per cent, 20.20 per cent in regard to cost on weed management and 2.49 per cent for cost of NCU/NU. However, increases of 19.96 per cent and 16.60 per cent were visible in case of cost of other items and total input costs respectively.
- Similarly, the analysis of impact of NCU on input cost of maize indicated decrease of 22.19 per cent and 3.28 per cent in costs of pest and disease control and weed management respectively.

However, it increased in case of cost of NCU/NU by 4.97 per cent, cost of other items by 16.67 per cent and in regard to total costs by 14.30 per cent.

- Economic feasibility of NCU by using Partial Budgeting Technique found an additional return from NCU of Rs. 609.94 per acre, an added return per acre for Rs. 2707.94 and benefit-cost ratio at 1.29 for paddy crop.
- Similarly, the economic feasibility of NCU by using the same Partial Budgeting Technique undertaken for maize crop indicated an additional return from NCU of Rs. 362.63 per acre, an added return per acre for Rs. 2048.50 and benefit-cost ratio at 1.21.
- Analysis in regard to some of the qualitative questions relating to impact on soil health reveals that soil texture, soil moisture retention capacities, water infiltration, soil softness and compaction of soil increased to 24 per cent to 53 per cent at overall crop level.

On the basis of interactions with the respondents and observed facts, the following interventions are suggested for policy actions meant for NCU & SHC:

- **NCU**

1. Training/demonstration programmes may be arranged for creating awareness about the benefits of NCU and its proper application.
2. Fertilizer outlets at Panchayat level should be ensured for easy access and to reduce transport costs on purchase of NCU.
3. Supply of fertilizer should be based on season's demand, so that neither black marketing nor rationing of NCU is made.
4. Strict supervision and monitoring for ensuring timely and quality supply of NCU be arranged.
5. To improve the usage of NCU, irrigation is pre-requisite, so irrigational back-up may be given at maximum level.

- **SHC**

1. Timely distribution of SHCs in hard copy and its dissemination should be ensured for adoption of RDF on the basis of soil test report.
2. Participation of farmers is desirable for successful implementation of SHC scheme, so right from collection of the soil samples to distribution of SHCs; their involvement may be mandated.
3. SHCs should be given to all farmers individually too, who belonged to one grid.
4. A co-ordinated and integrated approach comprising all agencies, such as; KVKs, STLs and others may be evolved for creating, as well as, spreading awareness about the benefits of soil health.
5. Adequate manpower, fund, technology and skill should be made available to the implementing agencies.
6. Proper training should be imparted to the farmers for collection of soil samples.
7. Since the SHC Scheme is related to soil health, so to expedite the same, soil health camps may be organized at village/panchayat levels at regular intervals.