Impact of Neem Coated Urea
on
Production, Productivity and Soil Health in India

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Agricultural Development and Rural Transformation Centre
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LIST OF ACRONYMS AND ABBREVIATIONS

ADRTC	Agricultural Development And Rural Transformation Centre
AERCs	Agro-Economic Research Stations
AS	Ammonium Sulphate
CAGR	Compound Annual Growth Rates
CAN	Calcium Ammonium Nitrate
CBs	Commercial Banks
CFs	Control Farmers
CP	Cold Pressed Oils
DAP	Diammonium Phosphate
DES	Department of Economics and Statistics
DoF	Department of Fertilizers
EC	Electric Conductivity
EG	Expeller Grade
FAI	Fertilizer Association of India
FAOs	Food and Agriculture Organization of The United Nations
FCO	Fertilizer Control Order
FYM	Farm Yard Manure
GCA	Gross Cropped Area
GoI	Government of India
GOI	Government of India
GoK	Government of Karnataka
GPS	Global Positioning System
GPs	Gram Panchayats
Hhs	Households
HYVs	High Yielding Varieties
IARI	Indian Agricultural Research Institute
IFA	International Fertilizer Industry Association
INM	Integrated Nutrient Management
ISEC	Institute for Social and Economic Change
K	Potassium
KVKs	Krishi Vignana Kendras
MMA	Macro Management of Agriculture
MoA&FW	Ministry of Agriculture and Farmers Welfare
MOP	Muriate of Potash
MP	Madhya Pradesh
MRP	Maximum Retail Price
MT	Million Tonnes
N	Nitrogen

LIST OF ACRONYMS AND ABBREVIATIONS

NCU	Neem Coated Urea
NFL	National Fertilizer Limited
NI	Nitrification Inhibition
NMSA	National Mission for Sustainable Agriculture
NOCU	Neem Oil Coated Urea
NPK fertilizers	Nitrogen, Phosphorus and Potassium fertilizers
NPMSF	National Project on Management of Soil Health and Fertility
NU	Normal Urea
NUE	Nitrogen Use Efficiency
OBC	Other Backward Classes
P	Phosphate
PCARDBs	Primary Cooperative And Agricultural Development Banks
PCFs	Polymer-Coated Fertilizers
RDFs	Recommended Doses of Fertilizers
RRBs	Regional Rural Banks
RSKs	Raitha Samparka Kendra's
SAUs	State Agricultural Universities
SC	Schedule Caste
SCU	Sulphur Coated Urea
SDA	State Department of Agriculture
SHC Scheme	Soil Health Card Scheme
SHCs	Soil Health Cards
SSP	Single Super Phosphate
ST	Schedule Tribes
STFs	Soil Tested Farmers
STLs	Soil Testing Laboratories
STLs	Soil Testing Laboratories
UP	Uttar Pradesh
USDA	United States Department of Agriculture
WB	West Bengal
ZnSO4	Zinc Sulphate

Acknowledgement

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The specific objectives of the study is to assess the impact of NCU on production, productivity and soil health in India, and to document the status and implementation of Soil Health Card scheme with a view to improve the efficiency of these significant initiatives using farm household survey in the sample states. The reference period for the study is Kharif 2015, and crops included are paddy, tur, maize, sugarcane, soybean and jute. In this report, perceptions of the farmers regarding Neem Coated Urea (NCU) as compared to Normal Urea (NU) and the status of Soil Health Card (SHC) Scheme have been documented.

In the course of study, immense support was received from the officials of the State Department of Agriculture, all participating states and the MoA & FW. In addition, our heartfelt thanks to all the participating AERCs and their team, for their support and active involvement throughout the study. We sincerely thank all of them for their cooperation.

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EXECUTIVE SUMMARY

Considering the importance of agriculture in meeting the increasing foodgrain requirements of the growing population of the country, fertilizers' as an input in agriculture production, assume greater significance in terms of ensuring a sufficient foodgrain production. However, an over use of fertilizers in general and urea in particular, over time, has affected soil quality, resulting thereby in a gradual reduction in yield levels, across the country. Urea is one of the most prominent fertilizers, which alone accounts for 57 per cent of the total fertilizer consumption in the country.

The continued efforts of researchers have led to the development of Neem-Coated Urea (NCU) which helps increase Nitrogen Use Efficiency (NUE) in crops. Neem has proved to be a significantly superior material as compared to other bio-coatable agents on account of its agronomic traits which are very supportive of plant growth, yield, grain and straw yields, nitrogen uptake and recovery. There are added advantages associated with NCU use relative to NU in terms of a slow release of urea, prevention of unabsorbed nitrogen from leaching into ground water aquifers or air besides improving the fertilizer (NPK) use efficiency.

Earlier, because of the fast nitrogen-releasing property of NU, the subsidized urea was diverted from agricultural purposes to industrial uses. However, this diversion of NU appears to have completely stopped in view of an abundant supply of NCU in the market during the reference period (Kharif 2015).

Recognizing the potential benefits associated with NCU relative to NU, the Ministry of Agriculture and Farmers Welfare (MoA & FW), Government of India, included NCU in the Fertilizer Control Order (FCO) since July 2004 and subsequently made the production and distribution of NCU mandatory from 25th May, 2015. Further, the Government of India launched a Soil Health Card Scheme (SHCS) on 19th February, 2015 with a focussed attention on improving the soil quality through a judicious use of fertilizers.

In order to explore the impact of NCU on production, productivity and income across select states of India and also to understand the status and implementation the SHC scheme, the Integrated Nutrient Management division of the MoA & FW entrusted a study to Agricultural Development and Rural Transformation Centre (ADRTC), Institute for Social and Economic Change (ISEC), Bengaluru.

With this background in view, the following objectives were addressed in this study:

1. To study the trends in usage and pricing of Urea and NCU.
2. To analyse the adoption behaviour of NCU-farmers under irrigated and rainfed conditions.
3. To analyse the impact of NCU use on yield and income.
4. To document the status and implementation of the soil health card scheme.

The present study relied upon both the primary and secondary data collected from six states, namely, Karnataka, Maharashtra, Madhya Pradesh, Bihar, Punjab and Assam for Kharif 2015. In the first stage, the crops occupying highest area under irrigated and rainfed conditions in the respective states were considered as a criterion for the selection of crops. Accordingly, six crops - paddy, tur/ redgram, sugarcane, maize, soybean and jute - were considered for the study. Of the six crops selected, paddy, sugarcane and jute were irrigated crops while maize, soybean and tur/red gram were rainfed crops. In the next stage, two districts were selected based on the gross cropped area in each selected sample state. Overall, 200 sample farmers for each crop were selected for the study. The sample was post classified into two groups, namely, NCU users and non-users (Normal Urea users- NU) and information was collected using a pre-tested questionnaire.

Major findings

The major findings of the study are as follows:

- The Secondary data based results indicate at an increase in consumption and price of urea at an annual rate of two per cent for the period from 2006-07 to 2015-16. The rising prices of DAP and MOP, as compared to those of urea, are considered one of the main reasons for an imbalanced usage of NPK fertilizers.
- Excepting the case of tur/ red gram, nearly 70 per cent of the farmers growing all the reference crops are aware of the availability of NCU in the market. Although they have been using NCU since long, a majority of them are not aware of the potential benefits associated with NCU use relative to NU. On the other side, the main sources of information on NCU happen to be the Department of Agriculture, followed by input suppliers and fellow farmers. More importantly, the awareness level is very low among the rain-fed farmers as compared to irrigated farmers.
- A comprehensive adoption of NCU by farmers across states and crops is not found among the selected households with respect to Kharif 2015 which could be due to various reasons such as undue delays in the supply and distribution of NCU, availability of old NU stock with input dealers, drought and uneven climatic factors prevailing across the country.

- Leaf-figure (symbol) on the bag, colour and price-difference are the major indicators for farmers in differentiating between NCU and NU.
- Only a small proportion of farmers has undergone trainings in the optimal application of fertilizers; and the State Department of Agriculture is the major organiser of trainings for farmers.
- Farmers' perceptions reveal that the quality of NCU supplied is good, adequate, and is timely available, easily accessible in the market besides being evenly distributed.
- As regards the benefits of NCU, relative to NU, a majority of the sample farmers have observed an improvement in the yield levels with respect to all crops and their by-products; however, differing responses are observed in respect of the cost of pest and disease control and weed management; and there is no change in the cost of NCU as well as of other fertilizers in the context of the application of NCU in place of NU.
- Nearly 52 per cent of tur-farmers and 61 per cent of paddy-farmers have found an improvement in the soil health characteristics such as soil texture, soil moisture retention, water infiltration and soil softness and water infiltration, while a reduction in soil compaction post-NCU application.
- An improvement in soil quality post the application NCU has been clearly reflected in the incremental increase in yield levels of main product and by-product with regard to reference crops as noticed by 98 per cent of sugarcane farmers, 63 per cent of jute farmers, 40 per cent of paddy and tur farmers each, 18 per cent of maize farmers and four per cent of soybean farmers. The increase in yield is to an extent of 38 per cent (1.46 quintal/acre) in soybean, 34 per cent (0.90 quintal/acre) in tur, 8 per cent each (1.62 and 1.87 quintal/acre) in paddy and maize, 5 per cent (26 quintal/acre) in sugarcane and 3 per cent (0.26 quintal/acre) in jute crops. However, in the case of by-products, an increase in yield has been observed with respect to paddy (3%=0.82 quintal/acre), tur/red gram (23%=0.45 quintal/acre) and soybean (11%=0.80 quintal/acre), while there is no change observed in respect of jute, maize, and sugarcane reference crops.
- A highest incremental yield is noticed in respect of paddy in the case of Madhya Pradesh (17%=2 quintal/ acre), while the lowest in the case of Punjab (1%=0.28 quintal/ acre). With respect to tur, both the highest main product (56%=1.8 quintals/ acre) and by-product (71%=1 quintal/ acre) yields are observed for Maharashtra.
- An increase in the cost to an extent of four per cent in respect of paddy and one per cent in respect of maize has been reported. Conversely, while a reduction in cost is noticed in the case of soybean (6%) and jute (2%). Further, a reduction in the cost of pest and diseases control and weed management has been noticed in respect of paddy, jute, maize and soybean post-adoption of NCU, whereas, these costs show an increase with respect to tur and sugarcane.

- A partial budget based results indicate at a highest incremental income in the case of tur (Rs.14940/acre), followed by sugarcane (Rs.5313/acre), soybean (Rs.2817/acre), paddy (Rs.2430/acre), jute (Rs.615/acre) and maize (Rs.363/acre) crops. Accordingly, the benefit-cost ratio works out to 10.21, 10.11, 4.28, 3.46 and 1.21 for the respective crops in the order of magnitude post-adoption of NCU.
- A significant impact to be noted is that the diversion of NU to other than crop production purposes is negligible among the farmers and in fact, it has completely stopped post introduction of NCU.
- Lack of awareness regarding the potential benefits associated with NCU use (100% in Madhya Pradesh and one-fourth in Assam and Karnataka) and high prices of NCU (95% in Punjab, 45% in Karnataka and 19% in Madhya Pradesh) are the major problems voiced by the farmers across states and crops.
- Under the SHC scheme, the achievement of targets in terms of sample testing and distribution of SHCs is limited to 50 per cent of the total sample collection, due to the lack of infrastructure facilities and staff. This might be the reason for the delay in the distribution of SHCs to farmers.
- The proportion of sample farmers who have tested their soil systems amounts to 35 per cent across the sampled states. With the highest being 33 per cent in respect of sugarcane farmers in Maharashtra and the lowest in the case of jute farmers in Assam (6%). Most of the farmers have not benefited from the soil health card scheme, due to the lack of awareness regarding the programme and associated benefits.
- Major sources like the State Department of Agriculture and KVKs are involved in creating awareness among farmers on the SHC scheme even as a majority of the sugarcane farmers in Maharashtra are reported to have gathered information from officers with sugarcane factories.
- Nearly half of the soil-tested-farmers have received SHCs on time, but only a few of them have followed partially the recommended doses of fertilizers application.

Policy Suggestions

Policy suggestions have been drawn based on the findings of the study and are presented under the following sub-headings:

Policy Suggestions on NCU

- The increase in crop yield levels of reference crops reflects the potential of NCU use. In order to realize the full potential of NCU, awareness should be created among farmers regarding an optimal use of NCU in order to realize maximum possible yield levels.

- There is a need for re-estimating the recommended doses of fertilizers, while keeping in view the neem-coated urea and its further inclusion in the package of practices.
- There is a need for addressing the concerns voiced by NCU users about its quality, availability, adequacy, timely supply and price through a planning and regulation.
- Special efforts on the part of the government are needed for ensuring a uniform pricing of NCU throughout the country as well as reduction in the price of NCU, as expressed by farmers and other stakeholders.
- The policy of mandatory production and distribution of NCU should be continued as its use helps improve soil health and crop productivity.

Policy Suggestions on SHC Scheme

- Special training programmes/ camps/ demonstrations should be organised by the various stakeholders (SAUs, KVKs, SDAs, Private Companies) as part of educating the farmers regarding soil sampling, benefits of soil testing, balanced use of chemical fertilizers and knowledge about SHC recommendations.
- There is a need for capacity building of the field level staff, required facilities and equipments such as Soil Test Laboratories (STLs), manpower, high quality instruments/devices for a successful implementation of the SHCs Scheme in the sample states.
- A majority of the field level staff have expressed that, the GPS available with the mobile does not work properly due to network and visibility problems during the day, as no GPS devices have been distributed to them. Hence, they are not able to collect the samples as per the procedures and targets set.
- A majority of the farmers across states and crops have reported delays in the distribution of soil testing reports/ soil health cards as the major problem facing the soil testing programmes, including SHC Scheme. As a result, farmers are more likely to lose their confidence in these programmes. Therefore, timely distribution of SHCs (before sowing season) in hard copy and educating farmers on the information available with SHCs should be promoted for adoption of recommended doses of fertilizers on the basis of soil test reports.
- A majority of the farmers have not treated SHC as an important document when it comes to testing their soil systems. Hence, there is a need for educating the farming community regarding the importance of soil health, benefits of soil testing, cards/ reports, and the information on SHCs, knowledge about SHC recommendations as part of encouraging farmers to make a judicious/ balanced use of chemical fertilizers.
- Gram Panchayats should be involved in undertaking soil testing campaigns on a war footing alongside the department of agriculture for a proper and better implementation of the soil health card scheme.


नीम लेपित
कृभको यूरिया
Neem Coated
UREA
46% N
FERTILISER
DO NOT USE HOOKS
Manufactured by :
SHAK BHARATI COOPERATIVE LIMITED
GROSS wt. 50.13 kg.

1. Introduction

1.1. Background of the Study

According to FAO (2015), the global fertilizer use is expected to cross above 200.5 million tonnes by 2018, 25 per cent higher than was recorded in 2008; the demand for nitrogen fertilizers is expected to grow fastest in Sub-Saharan Africa, at 4.6 per cent a year; East and South East Asia, together account for 60 per cent of all nitrogen fertilizer use; Asia as a whole is the largest consumer of fertilizer in the world and relies on import of all three major nutrients. With a highest irrigated land (36.8%) in the World, India placed in the 57th position in terms of consumption-fertilizer with 165.1 kg/ha of the arable land, as per the 2012-14 records of the **World Bank (2017)**. The urea consumption per hectare alone amounts to 155.90 kg/ha in the country; moreover, NPK consumption ratio for 2014-15 works out to 6.7:2.4:1(**DES, MoA, 2015**). Among the crops, maize, wheat and rice (cereals) are the three main fertilizer-consuming crops with their consumption proportion being relatively the same (i.e., 14-16% each) (**Patrick Heffer, 2010**).

The increasing trend observed over the years in the production of agricultural crops, especially food grains, has been the result of an increased consumption of chemical fertilizers and adoption of High Yielding Varieties (HYVs) across the country along with an expansion in groundwater irrigation. However, it is pertinent to note that this in turn, has resulted in nutrient deficiencies in soils and thereby as deficiency symptoms in plants. Therefore, to increase the yield levels, the demand for fertilizers has been growing across India as part of meeting the food security needs of the growing population.

Out of 17 nutrients, which are essentially required by crop plants for their normal growth and reproduction, Nitrogen (N) is generally required in largest quantum. Urea is one of the most widely used sources of fertilizer N in the world (**Dinesh, 2015**). The wide acceptance of urea is because of its agronomic acceptability and relatively of its lower cost as compared to other chemical fertilizers. It also has a high nitrogen content (46%), relative to many other popular nitrogen sources. The other forms of Nitrogen fertilizer produced and consumed in the country include Ammonium Sulphate (AS), Calcium Ammonium Nitrate (CAN) and Ammonium Chloride. Urea accounts for 82 per cent of the total consumption of straight N fertilizers. Other straight N fertilizers such as CAN and ammonium chloride account for only two per cent. The share of N in DAP and other complex fertilizers constitute about 16 percent (**FAO, 2005**).

The main reasons behind 'N' deficiency in crops are loss of 'N' through leaching, volatilization, surface run-off, denitrification, and plant canopy. Further, intensive agricultural production systems and the low rates of N fertilizers are the other reasons for 'N' deficiency in crops in

the context of developing countries (Fageria *et.al.*, 2003a). There has been a great interest in improving the Nitrogen Use Efficiency (NUE) through optimization of nitrogen use. By doing so, higher yields can be achieved with fewer negative impacts (for eg. Nitrogen leaching) (Agostini et.al., 2010; Burns, 2006; Neeteson and Carton, 2001; Rahn, 2002). In this respect, there exists a substantial empirical literature dealing with the demerits of urea, its adverse environmental impact through excessive nitrogen losses, and the need for development of new methods for improving the NUE in crops. As the synthetic fertilizer usage augmented, the impact became adverse and the scientists diverted their research towards finding the natural and eco-friendly chemicals. In this regard, neem based pesticides or chemicals are found to be much safer as they have no ill-effects on humans and animals nor residual effects on agricultural produce. **Bains *et.al.*, (1971)** were the first to have reported an increased NUE after treating urea with an ethanol extract neem seed.

The status paper on 'Enhancing nitrogen use efficiency challenges and options' by **Biswas and Subba Rao (2015)** reveals that average 'N' recovery efficiency for fields managed by farmers ranges between 20 per cent and 30 per cent under rainfed conditions and 30 per cent and 40 per cent under irrigated conditions. In this context, a field experiment conducted by the scientists (**Singh and Shivay, 2003**) of Indian Agricultural Research Institute (IARI) to study the effect of coating prilled urea with eco-friendly neem on two rice cultivars-hybrid rice (NDHR-3) and Pusa Basmati-1 found that NDHR-3 had performed relatively better than Pusa Basmati-1 for almost all the agronomic traits such as growth, yield attributes, grain and straw yields, nitrogen uptake and apparent N recovery. Among different sources of N, Pusa Neem Golden Urea proved to be significantly superior to other sources with regard to panicle length, grain yield, N uptake, agronomic nitrogen use efficiency, and apparent N recovery (%). In addition to all other selected traits, the application of NCU has helped reduce the environmental hazards. The use of NCU is found to be effective improving the uptake of N, P and K to a considerable extent. Based upon the results of extensive field trials, NCU has come to be considered agronomically superior to normal urea.

Realizing the various benefits associated with neem coating and its positive impact on environment, National Fertilizer Limited (NFL) developed a process for production of Neem Coated Urea (NCU) on a commercial scale in 2002. Later, understanding the potential of NCU and its acceptance by the farmers, Ministry of Agriculture, Government of India, included NCU in Fertilizer Control Order (FCO) since July 2004. Thus, NFL became the first company in India to have been permitted to produce and market NCU. This was mentioned in the Government of India Notification No S.O.807 (E) dated 9 July 2004. In the initial years, the total production of NCU was limited up to 35 per cent. Later, from March 2015, the Department of Fertilizer (DOF) made it mandatory for all indigenous producers of urea to produce 75 per cent of their production as NCU and from 25th May, 2015 the cap was increased to 100 per cent.

Intensive cropping and an unscientific application of synthetic fertilizers has led to a deterioration in soil health in the recent years, resulting in a sub-optimal use of resources, a cause for concern. On the other hand, a low addition of organic matters has led to an imbalanced use of fertilizers and non-replacement of depleted nutrients to nutrient deficiencies and a resultant decrease in soil fertility. In this context, both the state and central governments have tried to implement various schemes and programmes with respect to soil health as part of creating awareness among the farming community regarding the importance of soil health and its management based on soil test technology. The government has been encouraging farmers, through various subsidy programmes to go in for a free testing of soil health and distributing soil health cards (SHCs). Considering that it was difficult to cover the entire farming community, the governments have adopted a sampling framework for assessing the soil health status at the lowest block levels by way of making general fertilizer recommendations based on their highest area under major crops across the targeted districts. Generally, soil test values vary over a period of three years and hence, it has been recommended to the farmers to test their soils at least once in three years.

In this regard, the Government of India launched a Soil Health Card Scheme on 19th February, 2015 with a focused attention on soil health in agricultural areas across the country as part of enhancing productivity through a judicious use of inputs, especially fertilizers. Under this scheme, the soil testing is done for its main characteristics such as organic carbon, PH, electrical conductivity, macro and micro nutrients, degradation type, colour, texture and so on. The reports are given in the form of a SHC, which contains crop-wise recommendations for fertilizer use. It has helped farmers identify the health of soil systems and a judicious use of soil nutrients through proper monitoring. In this study, an attempt has been made to understand and document the issues related to the status and implementation of the SHC programme.

1.2. A Review of Literature

In this section, various research studies related to the historical development of NCU and its superiority vis-a-vis Normal Urea (NU) have been reviewed and discussed in a chronological order as under:

Nitrogen application has both the advantages and disadvantages. The advantages of Urea application are: (i) it is one of the macro nutrients frequently required in a crop fertilization programme with a high nitrogen content; (ii) it initiates a healthy vegetative growth and is necessary for the photosynthesis process of plants, besides being widely used as an excellent fertilizer for plant growth; (iii) it can also be used in a number of products such as animal feed, commercial products, glue, resin, cosmetics, pharmaceuticals, dish soaps, hair conditioners, tooth whiteners and so on. On the other hand, disadvantages of Urea application include: (i) it is easily soluble in water and decomposes even at room temperature that results in a serious loss

of nutrients; (ii) it has an adverse effect on seed germination, seedling growth, and early plant growth in soil (**Bremner and Krogmeier, 1988**); (iii) an excess nitrogen, which is not absorbed by plants, leaches into groundwater aquifers and rivers and subsequently enters human body as drinking water, resulting in health disorders (**Majumdar and Gupta, 2000**); (iv) an excessive release of air and water-borne nitrogen from fertilizers may cause respiratory ailments, cardiac disease and cancer; (v) it can inhibit crop growth besides being affecting the dynamics of several vector-borne diseases (**Townsend *et.al*, 2003**).

NUE is the result of two main components: (i) 'N' uptake efficiency - the ability of crops to absorb 'N' from the soil (**Burns, 2006; and Greenwood *et.al*., 1989**); and (ii) use efficiency - the efficiency with which crops use the absorbed 'N' for a high yield (**Janssen, 1998; Schenk, 2006**). These efficiencies may differ within the same crop because they depend on different organs and mechanism, and different environmental factors.

The research conducted by **Fageria and Baligar, (2005)** has led to the development of new methods towards increasing NUE in crops. These approaches include a slow release of N-fertilizers; chemicals that inhibiting biological N-transformation in soils; amendments to N-fertilizers; coating techniques using coating agents such as sulfur, shellac, gypsum, ground rock phosphate; adoption of appropriate soil and plant management practices and improving the biological and non-biological nitrogen fixation.

Roxburgh (1874) lista neem as a tropical evergreen tree native to the Indian sub-continent. It has a great potential in the field of pest management, environment protection and medicine. It is a natural source of eco-friendly insecticides, pesticides and agrochemicals (**Brahmachari, 2004**). The tree is said to have anti-microbial properties besides being used as a bio-control agent in controlling plant diseases (**Kak, 2000**).

The field experiments have shown that neem cake stimulates algal growth; triples biomass and increases N-fixation activity by ten-fold (**Grant *et. al*., 1983**). Further, admixing neem cake with urea fertilizer improves the efficiency of fertilizer utilization in crop production through a gradual release of nitrogen to crops (**Ketkar, 1983**). During 1986 and 1987, **John *et.al*., (1989)** had conducted field experiments by coating urea with 0.2g neem cake per g urea and found that there was no loss of urea-N in the successive field experiments for the years 1986 and 1987, conducted across lowland rice fields following two cowpea cropping systems before rice in Philippines. However, the results show a significant increase in grain yield (0.4 Mg ha^{-1}) and the total plant N uptake (11 kg ha^{-1}) for 1987, not for 1986.

Govindachari (1992) reported that Robert Larson was the person to have observed the use of neem extract in the rural areas of India for saving crops from insects and the multifarious uses

of neem products in villages. With advice and assistance from USDA, Baltimore, Maryland, USA, he developed a neem kernel formulation, named Margosan-O, standardised to contain 3000ppm azadirachtin. When diluted 150-fold, this would afford a spray solution with 20ppm azadirachtin, adequate to control many pests.

Nagalakshmi *et.al.*, (1996) and Verma *et.al.*, (1998) observe that Neem kernel cake mixed with poultry feed results in an increased feeding value and protein utilization with a spectacular growth.

Majumdar and Gupta (2000) observe that an excess nitrogen not absorbed by plants leaches into groundwater aquifers and rivers and subsequently enters human body as drinking water, resulting in health disorders.

Townsend *et.al.* (2003) report that urea can inhibit crop growth besides affecting the dynamics of several vector-borne diseases.

The past studies have shown that neem plant residue is a potential source of organic manure (**Brahmachari, 2004**); neem cake coated urea increases nitrogen assimilation as compared to untreated urea; neem leaves have both fertilizer and pesticidal potential when used in the preparation of vermi-compost (**Gajalakshmi and Abbasi, 2004**).

Apart from using neem as a natural pesticide and an admixture of fertilizers in agriculture, it is also used as animal feed. A research study shows that neem leaf meal contains 92.42 per cent dry matter, 7.58 per cent moisture, 20.68 per cent crude protein, 16.60 per cent crude fibre, 4.13 per cent ether extract, 7.10 per cent ash and 43.91 per cent nitrogen-free extract (**Esonu *et. al.*, 2005; Oforjindu, 2006; Ogbuewu, 2008**).

Dayan, *et.al*, 2009 point out that a chemical content in neem 'azadirachtin' is a potent antifeedant to many insects (**Isman, 2006**) such as aphids, armyworms and other caterpillars, beetles (including Colorado potato beetle), borers, budworms, cutworms, leafhoppers, leaf miners, lepidopterist larvae, loopers, lygus, maggots, mealy bugs, psyllids, scale, stink bugs, weevils, whiteflies and other insects.

To develop standard specifications for neem oil as a raw material in Neem Oil Coated Urea (NOCU), a study was undertaken by **Kumar Rajesh *et.al.***, during **2007**. They evaluated 25 samples of neem oils comprising 11 samples of expeller grade (EG) oils, 8 samples of cold pressed (CP) oils, 3 samples of solvent-extracted oils and 2 commercial formulations. The soils fertilized with NOCUs (200 ppm of urea-N) were incubated at 27^{o}C and 50 per cent water-holding capacity for a period of 15 days with Nitrapyrin (0.5% of N) coated urea kept as the reference and prilled urea as control. Samples were analysed for NH_4 +-N, NO_2 --N, and NO_3 --N, using

standard methods and calculated % nitrification inhibition (NI). The results revealed that all of the neem oils had caused NI ranging from 4.0 to 30.9 per cent. It was found that two samples of EG oils and two commercial formulations were the best, causing 27.0-30.9 per cent NI.

A study was carried out on the efficiency of different urea treatments like prilled urea (Pu), Pu (2 splits), PU (4 splits), Sulphur Coated Urea (SCU) and Neem Coated Urea (NCU) at the rate of 360 kg N/ha on fresh and dry herb yield, nitrogen use efficiency and essential oil production of lemon balm plant. The results showed that urea fertilizer had significantly increased the dry herb and essential oil yields of the plant as compared to control. However, the impact was highest in the case of dry herb yield, essential oil yield (l/ha), N uptake, N recovery, N-agronomy efficiency, while, N-physiological efficiency was highest in respect of over prilled urea by using SCU, Pu (4 splits) and NCU, respectively as compared to other urea treatments (**Aziz and El-Ashry, 2009**).

A study conducted by **Akiyama *et.al.***, (2010) on the overall effectiveness of enhanced efficiency-fertilizers such as nitrification inhibitors (NIs), polymer-coated fertilizers (PCFs) and urease inhibitors (UIs) on N_2O and NO emissions based on a meta- analysis using field experiment data, indicated that NIs and PCFs had significantly reduced N_2O emissions as compared to those of conventional fertilizers, whereas, UIs were not effective in reducing N_2O. The effectiveness of NIs was relatively consistent across the various types of inhibitors and land uses, while PCFs showed contrasting results in the case of soil and land use type in that they were significantly effective for imperfectly drained Gleysol grassland, but ineffective for well-drained Andosol upland fields. NIs were effective in reducing N_2O emissions from both the chemical and organic fertilizers.

1.3. Need for the Study

The NCU is superior to Normal Urea (NU), as indicated by extensive laboratory and field experiments conducted by various scientists worldwide. The application of NCU minimizes loss due to leaching; prevents its misuse as well as puts the fertiliser in a slow release mode thereby nourishing the saplings for a longer period; avoids the repeated use of fertilizer and economize the quantity of urea required by crops (enhancing Nitrogen-Use Efficiency); increases the shelf-life of the product; reduces caking during storage and improve the availability of nitrogen to crops; results in a better crop yield and efficient pest control management; reduces the leaching of nitrates into the groundwater aquifers and thereby help reduce its pollution and so on. Further, there was a notion that NCU had stopped the diversion of urea into non-agricultural/ industrial purposes. Keeping this in view, the Government of India included neem coated urea, a slow release fertilizer, in the Fertilizer (Control) Order, 1985 besides making it mandatory for all the indigenous producers to produce 100% of their total subsidized urea in the form of NCU from 2015. Further, it has since taken various steps to promote NCU use with a view to

improving the soil health status and also realising a higher yield per hectare. Therefore, the INM division of the Ministry of Agriculture entrusted the ADRT centre of ISEC to study and assess the impact of NCU on the production and yield of major crops in India. Accordingly, the current study examined the coverage of NCU, adoption behaviour of farmers and its impact on yield levels with respect to major crops across the selected states. Besides, the study also tried to understand the diversion of Urea/NCU to other than agriculture within the farming community and document the baseline information on the status and implementation of the soil health card scheme across the selected states of the country.

1.4. Objectives of the Study

The specific objectives of the study included:

1. To study the trends in usage and prices of Urea and NCU.
2. To analyse the adoption behaviour of NCU farmers in irrigated and rainfed conditions.
3. To analyse the impact of NCU on yield and income.
4. To document the status and implementation of soil health card scheme.

1.5. Limitations of the study

The following are the important limitations of the present study:

i. The study was undertaken on a short notice post the policy implementation of a 100% production of NCU (since, May 2015) and hence, it is difficult to assess the impact of NCU on crop production, productivity and farmers income within a limited period. However, the reference period of the study is Kharif 2015.
ii. There was a lack of timely availability of NCU during Kharif 2015, due to a delay in the policy implementation. Further, there was a stock of normal urea available in the market during the study period and hence, a few farmers had applied both NCU and Normal Urea.
iii. Since, the mandatory production of NCU, being commissioned for the first time in the country, there was a lack of awareness observed among the farming community regarding the NCU use.

Therefore, a majority of the respondents couldn't differentiate between NCU and Normal Urea. Further, the fertilizer dealers had made it even more difficult for the farmers by selling both the fertilizers at almost the same rate, although, there was a slight increase observed in the prices of NCU.

1.6. Data and Methodology

The present study relied on primary and secondary data collected from selected states in India with the reference period being Kharif 2015. Both irrigated and rainfed crops accounting for the highest urea in each of the selected states were considered for the study. For each crop, two districts were selected based on the area under the selected crop and their urea usage within the state. From each district, two taluks/tehsils were selected based on the same criterion. Within the selected taluks, two clusters of villages comprising 3-4 villages per cluster were selected for conducting the survey. A total of 50 farmers from each taluk were selected with the total farmers adding up to 100 from each district. Households were selected randomly for assessing the NCU fertilizer use and its impact on crop production. The households were classified in to two categories, NCU users and non-users (those using Normal Urea) mainly to examine the impact of NCU as compared to NU. Further, an adequate care was taken to ensure that the selected crops were grown under chosen irrigated/un-irrigated conditions in the state. Thus, a total of 200 (NCU/ Normal Urea) farmers for each crop were interviewed using a pretested structured questionnaire. An adequate care was taken in the selection of a representative sample based on the operational land holding size.

The information gathered from both primary and secondary sources are analysed using tabular analysis. In addition, CAGR, Exponential functions, partial budgeting framework and paired unequal sample 't' test (between NCU and Non-NCU farmers for the year 2015) also have been used to observe the significance difference between two categories of farmers with respect to various indicators.

1.7. Organization of the Final Report

The present report has been divided into seven chapters. First Chapter provides an introduction including the need for the study, objectives, methodology details and the limitations of the study. The second Chapter presents the trends in urea consumption in India.

The third Chapter focuses on the socio-economic characteristics of the sample households, while, the fourth Chapter brings out the status of awareness and application of NCU.

The status of the Soil Health Card scheme, its implementation and adoption of soil testing technology by the farmers are discussed in the fifth Chapter.

Sixth Chapter highlights the impact of NCU application on crop production, productivity, soil health and farmers' income followed by a summary of major findings and policy suggestions in concluding Chapter.

2. Trends in Urea Consumption

2.1. Trends in urea consumption and price variation

Trend analysis is the most common practice in terms of collecting information and attempting to spot a pattern. This technique is often used in extracting an underlying behavioural pattern based on a time series data which remains partly or wholly hidden by noise. This method helps understand, how and why things have changed or will change over time. A simple description of these techniques is called trend estimation which can be undertaken by a simple or multiple regression analysis. Urea is the most important nitrogenous fertilizer. There are three main reasons for urea fertilizer being the king of fertilizers: First, it has a high nitrogen content of about 46 per cent; secondly, it is a white crystalline organic chemical compound. It is neutral in character and can adapt to almost all types of land. It is a waste product formed naturally by metabolizing protein in human beings as well as other mammals, amphibians and some fish; thirdly, urea is widely used in the agricultural sector both as a fertilizer and animal feed additive.

Urea accounts for 57.30 per cent of the total fertilizer consumption for 2015-16 in India, but the country is not self-sufficient in urea production as its consumption has been rising steadily since 2006-07. This is clear from **Table 2.1** and **Figure 2.1** that the compound annual growth rate (CAGR) for production and consumption of urea in India for the period 2006-07 to 2015-16 amounts to 2.10 and 2.80 per cent per annum correspondingly. The domestic urea production has increased from 202.71 lakh MTs in 2006-07 to 245 lakh MTs in 2015-16, while, the consumption has increased from 243.38 lakh MTs in 2006-07 to 319.68 lakh MTs in 2015-16, leading to a widening gap between domestic production and consumption in the process. This in turn, has forced the government to raise urea imports. It is also noticed from Table 2.1 that the urea imports have increased from 47.19 lakh MT in 2006-07 to 90.84 lakh MT by 2015-16, with a significant growth of 6.11 per cent per annum.

For a sustained agricultural growth and promotion of a balanced nutrient application, it is imperative on the part of the government to make available fertilizers at affordable prices to the farming community. With this objective, urea being the only controlled fertilizer, is sold at a statutory notified uniform sale price, while, decontrolled Phosphatic and Potassic fertilizes are sold at indicative maximum retail prices (MRPs). The problems faced by the manufacturers in earning a reasonable return on their investment with reference to controlled prices are mitigated by providing support under the New Pricing Scheme for Urea units, and the concession Scheme for decontrolled Phosphatic and Potassic fertilizers. The statutorily notified sale price and indicative MRP are generally less than the cost of production irrespective of the

manufacturing unit. The difference between the cost of production and the selling price/MRP is paid as subsidy/concession to the manufacturers. As the consumer prices of both indigenous and imported fertilizers are fixed uniformly, financial support is also given on imported urea and decontrolled Phosphatic and Potassic fertilizers. It is clearly understood from Table 2.1 that the price of urea per bag marginally increased from Rs 262.50 in 2006-07 to 268 in 2015-16, with a growth rate 0.90 per cent, which is relatively constant since and has a statutory notified uniform sale price fixed by GOI.

Table 2.1: Trends in all India urea production, import, consumption and prices

(lakh MT)

Years	Production	Import	Consumption	Price (Rs./bag)
2006	202.71	47.19	243.38	262.50
2007	198.39	69.28	259.63	262.50
2008	199.23	56.67	266.49	262.50
2009	211.21	52.10	266.73	241.50
2010	218.73	66.10	281.13	265.50
2011	219.92	78.34	295.65	288.50
2012	225.87	80.44	300.02	291.25
2013	227.19	70.88	306.00	291.25
2014	225.93	87.49	306.10	268.00
2015	245.00	90.84	319.68	268.00
CAGR	2.10***	6.11**	2.8***	0.90**

Source: FAI, 2015

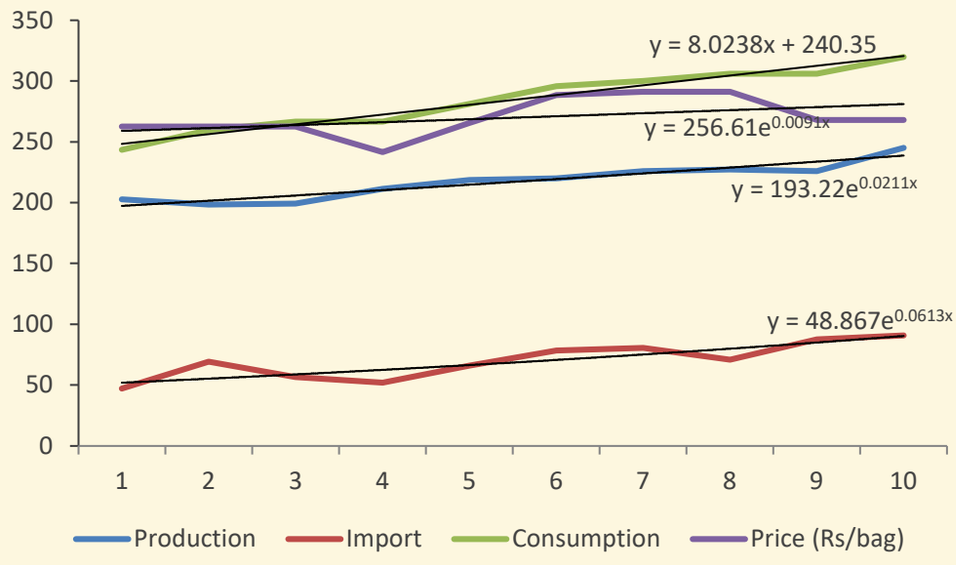


Figure 2.1: All India urea production, imports, consumption and prices

2.2. State-wise trends in consumption/sales in urea

The state-wise trends in consumption/sales of urea are presented in **Table 2.2** and **Figure 2.2**. It is revealed from the table that at the aggregate level, the consumption of urea has increased from 8542.92 thousand MTs in 2006-07 to 11376.76 thousand MTs in 2015-16, with a growth rate of 2.94 per cent, which is statistically found significant at five per cent level. Among the selected states, the highest growth rate has been observed for Assam (5.50%) followed by Madhya Pradesh (5.10%), Karnataka (2.92%), Maharashtra (2.13%), Punjab (1.92%) and the least in the case of Bihar (1.81%), respectively. The percentage change over is also used for indicating the quantum of change from 2006-07 values to the existing values. It is observed from Table 2.2 that the percentage change over from 2006-07 to 2015-16 is highest in respect of Assam (102.10%) followed by Madhya Pradesh (68.85%), Karnataka (33.27%), Punjab (30.15%), Bihar (21.73%) and Maharashtra (15.86%). It is also clear from the table that at the aggregate level, the changeover observed in consumption/ sales in urea amounts to 33.17 per cent.

Table 2.2: State-wise trends in urea consumption

(000 MTs)

Years	Assam	Bihar	Karnataka	Maharashtra	MP	Punjab	All India
2006	194.10	1598.10	1097.58	1985.00	1297.00	2371.14	8542.92
2007	195.41	1851.72	1253.63	2131.00	1425.00	2646.44	9503.20
2008	223.48	1794.82	1281.99	2258.00	1371.00	2576.90	9506.19
2009	251.31	1701.11	1377.07	2289.00	1603.00	2445.76	9667.25
2010	256.61	1691.21	1427.71	2538.00	1669.00	2720.44	10302.97
2011	304.61	1811.51	1444.80	2481.00	1788.00	2825.70	10655.62
2012	278.93	2095.96	1446.32	2332.00	1856.00	2842.97	10852.18
2013	281.51	1870.64	1479.20	2655.00	2224.00	2619.32	11129.67
2014	299.53	1940.41	1532.60	2572.00	2017.00	2734.26	11095.80
2015	392.39	1945.52	1462.80	2300.00	2190.00	3086.05	11376.76
CAGR	**5.50****	**1.81****	**2.92*****	**2.13*****	**5.10*****	**1.92****	**2.94*****
% change over from 2006-07 to 2015-16	**102.10**	**21.73**	**33.27**	**15.86**	**68.85**	**30.15**	**33.17**

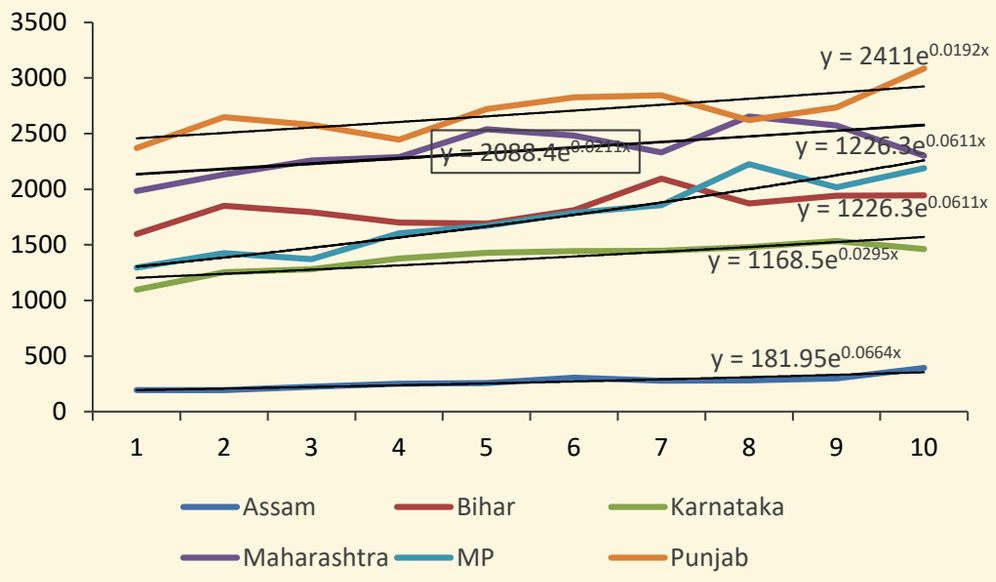


Figure 2.2: State-wise trends in urea consumption (000 MT)

2.3. State-wise percent share in consumption/ sales of urea

The state-wise per cent share in consumption/sales of urea from 2006-07 to 2015-16 is presented in **Table 2.3**. A perusal of the table reveals that, among the selected states, the highest percentage of urea consumption or sales is registered in Punjab i.e., 23 to 27 per cent (range) for the reference period (2006-07 to 2015-16). This could be due to the presence of a higher irrigated area and a major area under the cultivation of paddy and wheat crops in the state. Moreover, the farmers in the state, apply a higher quantity of fertilizers including urea, for an overall plant growth and higher productivity. Next to Punjab, a higher share of urea consumption is noticed in the case of Maharashtra, wherein, the share ranges from 20 to 25 per cent for the reference period. Madhya Pradesh accounts for the third highest urea consumption with its share ranging from 14-19 per cent, followed by Bihar, with a share ranging from 16 to19 per cent. Interestingly, Karnataka State exhibits a relatively similar trend in urea consumption with a share of about 13 per cent throughout the study period, while, the consumption trend in urea is very meagre (just about three per cent) in respect of Assam which may be due to the state's inclination towards organic agriculture with the help of the central government.

Table 2.3: State-wise percentage share of urea consumption in the total urea consumption

(%)

Years	Assam	Bihar	Karnataka	Maharashtra	MP	Punjab	All India
2006	2.27	18.71	12.85	23.24	15.18	27.76	100.00
2007	2.06	19.49	13.19	22.42	14.99	27.85	100.00
2008	2.35	18.88	13.49	23.75	14.42	27.11	100.00
2009	2.60	17.60	14.24	23.68	16.58	25.30	100.00
2010	2.49	16.41	13.86	24.63	16.20	26.40	100.00
2011	2.86	17.00	13.56	23.28	16.78	26.52	100.00
2012	2.57	19.31	13.33	21.49	17.10	26.20	100.00
2013	2.53	16.81	13.29	23.86	19.98	23.53	100.00
2014	2.70	17.49	13.81	23.18	18.18	24.64	100.00
2015	3.45	17.10	12.86	20.22	19.25	27.13	100.00

Source: FAI, 2015

2.4. State-wise trend in urea prices for the period from 2006-07 to 2015-16

Chemical fertilizers in general and nitrogenous fertilizers in particular have made a major contribution to agricultural productivity. Of which, nitrogenous fertilizers account for 57 per cent of the total fertilizer consumption for 2014-15 (FAI, 2015). For the overall welfare of farmers, it has been the policy objective of the government to keep fertilizer prices at affordable levels. To pursue this objective, the government has been controlling the prices of urea and selling at the statutory notified uniform sale price. Keeping this objective in view, the study attempted to examine the trends in urea prices for the reference period from 2006-07 to 20015-16, and the results are presented in **Table 2.4**. Overall, it is observed that, the prices of urea rose from Rs.267.44 per bag in 2006-07 to Rs.281.25 per bag in 2015-16, with an annual growth rate of 0.70 per cent.

Among the selected States, the highest annual growth in urea price (two per cent) is noticed in respect of Madhya Pradesh, followed by Punjab and Maharashtra (0.80% each) and Karnataka (0.60%). Moreover, these growth rates are found statistically significant at within five per cent level. Whereas, in the case of other states, the growth is insignificant. From these results, it can also be conclude that the growth in urea prices noticed in those states could be due to an increased irrigation facility with farmers using a higher quantity of nitrogenous fertilizers.

It is evident from the data that the urea prices have increased marginally across States after 2006-07. In 2010, the government of India introduced a product-based subsidy regime for P and K fertilizers such as DAP and MOP respectively. The MRP of P and K fertilizers (and their complexes) is left open to be fixed at a 'reasonable rate' by fertilizer companies on the basis of demand-supply, after incorporating the subsidy element. However, urea prices continued to be controlled by the government. Over the period from 2006- 07 to 2015-16, the rate of increase in urea price amounts to almost five per cent at the aggregate, which is very negligible in comparison to MRP of DAP (171.2%) and MOP (277.6 %). With the rising prices of fertilizers in the global market, the prices of P and K fertilizers have increased considerably in the domestic market also. It is noticed that in April 2010, almost 38 per cent (in the case of DAP) and 25.6 per cent (in case of MOP) of the total cost of fertilizers under nutrient-based subsidy regime was borne by the farmers. By 2012-13, the percentage share of the total cost borne by farmers became 66.58 per cent and 61.1 per cent for DAP and MOP, respectively (Gulati and Banerjee, 2015). The rising prices of DAP and MOP as compared to urea are considered one of the main reasons for an imbalanced usage of NPK fertilizers. Among different States, the highest increase in the urea price of Rs.35 per bag (difference-price) is observed in the case of Madhya Pradesh, followed by Maharashtra (Rs.18 per bag), Punjab (Rs.15 per bag), Karnataka (Rs.13.5 per bag) and Bihar (three rupees only). Interestingly, a decline in the urea price is observed in the case of Assam (Rs.1/-). The same results are also depicted in **Figure 2.3**.

Table 2.4: State-wise trends in urea Prices

(Rs/bag)

Years	Assam	Bihar	Karnataka	Maharashtra	MP	Punjab	All India
2006	273.50	295.63	286.00	266.00	230.00	253.50	267.44
2007	273.50	295.63	286.00	268.00	230.00	253.50	267.77
2008	273.50	295.63	286.00	268.00	230.00	253.50	267.77
2009	273.50	295.63	286.00	268.00	230.00	253.50	267.77
2010	273.50	298.00	286.00	284.00	230.00	265.50	272.83
2011	273.50	298.00	286.00	284.00	230.00	265.50	272.83
2012	273.50	298.00	299.50	284.00	265.50	268.00	281.42
2013	273.50	298.00	299.50	284.00	265.50	268.00	281.42
2014	272.50	298.00	299.50	284.00	265.50	268.00	281.25
2015	272.50	298.00	299.50	284.00	265.50	268.00	281.25
CGR	-0.04NS	0.10NS	0.60***	0.80**	2.00**	0.80**	0.70**

Source: FAI, 2015

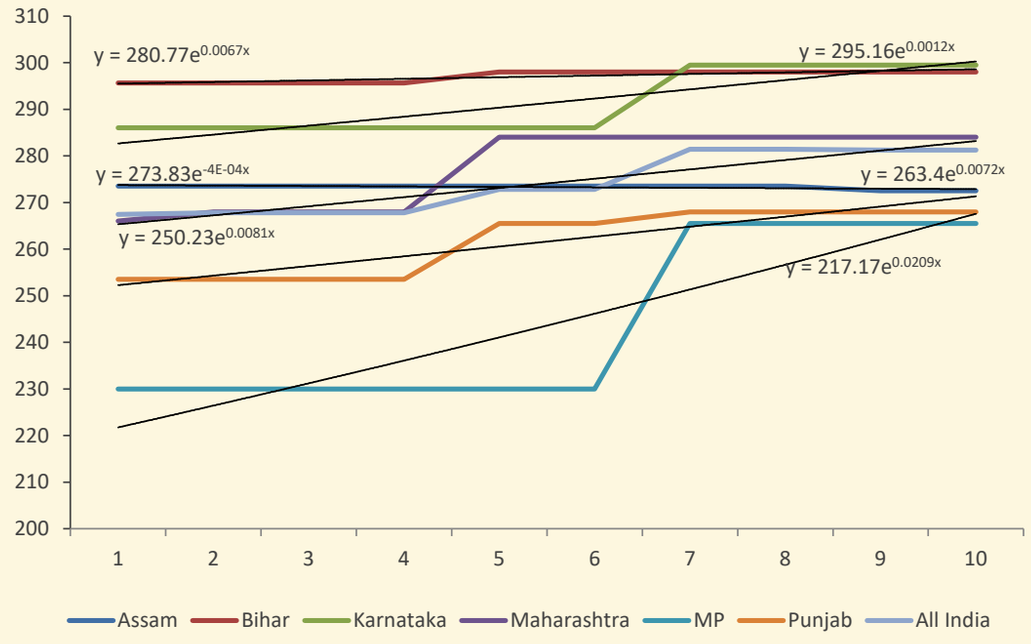


Figure 2.3: State-wise trends in urea prices (Rs./bag)

2.5. Growth rate of urea prices over the period 1980-81 to 2015-16

The compound annual growth rate of urea prices from 1980-81 to 2015-16 and their decadal growth rates have been worked out separately, and the results are presented in **Table 2.5**. It is observed from the table that the highest decadal growth rate of urea prices increased significantly at the rate of 5.21 per cent per annum for the period 1990-91 to 1999-2000. For the remaining years, the increase in growth rate of urea prices works out to less than one per cent per annum. Accordingly, the annual growth rate for the period 1980-81 to 2015-16 amounts to 3.33 per cent and is found statistically significant at five per cent level.

Table 2.5: Compound Annual Growth Rate of urea prices for the period 1980-81 to 2015-16

Period	CAGR (% per annum)
1980-81 to 1989-90	0.49
1990-91 to 1999-00	5.21**
2000-01 to 2015-16	0.92**
1980-81 to 2015-16	3.33**

**Significant at one per cent level

2.6. Summary of the chapter

Chemical fertilizers in general and nitrogenous fertilizers in particular, have made a major contribution towards agricultural productivity. Of which, nitrogenous fertilizers accounted for 57 per cent of the total fertilizer consumption in 2014-15. But, still it is not self-sufficient, as its consumption has been rising steadily. Alternatively, urea imports have increased with a significant growth of 6.11 per cent per annum. The compound annual growth rate (CAGR) for production and consumption of urea in India for the reference period (2006-07 to 2015-16) amounts to 2.10 and 2.80 per cent per annum, correspondingly. The price of urea per bag has marginally increased at a less than one per cent. Among the selected states, the highest growth rate is observed in respect of Assam (5.50%), followed by Madhya Pradesh (5.10%), Karnataka (2.92%), Maharashtra (2.13%), Punjab (1.92%) and the least in the case of Bihar (1.81%). At the aggregate level, the highest percentage of urea consumption or sales is found registered by Punjab (23 to 27%), followed by Maharashtra (20 to 25%) and Bihar (16-19%) throughout the study period. It may be due to the presence of a higher irrigated area and a major area under cultivation of paddy and wheat crops. In addition, farmers also apply a higher quantity of fertilizers including urea for overall plant growth and higher productivity. The consumption trend in urea is very insignificant (less than three per cent) in Assam, which may be due to the state's inclination towards organic agriculture with the help of the central government. From 2006- 07 to 2015-16, the rate of increase in urea price works out to almost five per cent at the aggregate level, which is very negligible in comparison to MRP of DAP (171%) and MOP (278%). In addition, the highest decadal growth rate of urea prices increased significantly at the rate of 5.21 per cent per annum during the period 1990-91 to 1999-2000. For the remaining years, the increase in growth rate of urea prices amounts to less than one per cent per annum.

Visit to Fertilizer Gowdon by the Research Team

3. Socio-Economic Characteristics of the Sample Households

To understand the socio-economic conditions of the sample farmers, the information collected from them relating to family size, its composition, literacy status, caste, land using pattern, operational holdings, cropping pattern, production, pattern of inputs usage, sources of irrigation, asset holdings, credit details, training programs attended on fertilizer application, yield levels, and profitability of the reference crops has been analysed and discussed in detail in this chapter. These characteristics of the respondents play an important role in the process of adoption of any technology in the agricultural sector.

3.1. General characteristics of the sample households

The general characteristics of the overall sample farmers are shown in **Table 3.1.** It can be clearly seen from the table that there are wide variations in the socio-economic characteristics of the farmers across the sample States with respect to different crops.

Table 3.1: General characteristics of the sample farmers

Sl. No.	Particulars	Paddy	Tur	Sugar-cane	Maize	Soybean	Jute	Overall
1.	Average age of respondents (Years)	46	48	47	49	45	44	46
2.	Male respondents (%)	99.30	98.00	99.00	100.00	95.00	100.00	98.50
3.	Average family members engaged fully in farming (No.)	3	3	3	2	4	2	3
4.	Average years of farming experience	23	27	28	19	25	22	24
5.	Average family size (No.)	7	7	7	7	7	6	7
6.	Literacy level (% farmers)							
i	Illiterates	9.40	12.25	2.00	-	25.50	20.50	11.60
ii	Primary (1 to 4)	8.20	29.00	7.50	21.50	23.50	48.50	23.03
iii	Higher primary (5 to 9)	19.10	15.50	19.00	18.00	38.00	17.00	21.10
iv	Matriculation (10)	19.70	19.75	26.50	19.50	06.50	6.00	16.32
v	Pre-University (10+2) & above	43.60	23.50	45.00	41.00	06.50	8.00	27.95
7.	Caste (% farmers)							
i	General	51.90	43.75	72.50	25.50	11.00	98.90	50.59
ii	OBC	37.70	34.25	14.00	58.50	30.00	01.10	29.25
iii	SC	5.80	8.50	4.00	8.50	37.50	-	10.71
iv	ST	4.60	6.25	0.50	7.50	21.50	-	6.75
v	Others	-	7.25	9.00	-	-	-	2.70

Source: Primary Survey

The table reveals that the average age of farmers of sample States is 46 years with a majority of them being male respondents. On an average, the family consists of seven members out of which three are engaged in farming with an experience of 24 years. These characteristics are relatively similar with respect to the respondents growing different crops and across States. With regard to the literacy level, a majority (28%) of them have studied Pre-University and above followed by primary schooling (23%), higher primary (21%) and matriculation (16%); however, about 12 per cent of them are also found to be illiterates. Across crops, a majority (>60%) of the paddy, sugarcane and maize farmers have completed matriculation and above while, in the case of tur, soybean and jute, more than half of the farmers have studied up to higher primary level. At the aggregate level, a majority of the sample farmers belong to general category (51%) followed by Other Backward Classes (OBCs) (29%), Scheduled Castes (11%) and Scheduled Tribes (7%). Except in the case of maize, the proportion remains relatively the same in respect of all the crops. However, a more than half of the maize farmers (58%) belong to OBC category.

3.2. Details of operational land holdings

The details of operational land holdings of the sample farmers (presented in **Tables 3.2a and 3.2b**) indicate that the average net operational area in the study region is comparatively higher in the case of sugarcane farmers (12.6 acres/ household) than paddy (10.80 acres/ household) and tur farmers (10.34 acres/ household). The least net operational area (6.37 acres/ household) is found among jute farmers, while, in respect of the rest of the cases such as soybean and maize, the net operational area works out less than 10 acres/ household. As usual, the highest operational land is with the large farmers only with respect to all the sample crops, however, it is found as high as 27 acres/ household in the case of sugarcane growers followed by maize (20.80 acre/ household) and tur farmers (19.25 acres/ household). Overall, a substantial proportion of the operational area is constituted by land owning farmers (>7 acres/ household) across all crops. Interestingly, the leased-in area seems to be highest in the case of paddy crop only (2.25 acres/ household), while the proportion is less than an acre/ household in respect of the rest of the crops. On the contrary, the leased-out area constitutes less than an acre/household across crops, however, it is highest (0.75 acre/ household) with respect to maize crop in Bihar. Similarly, the proportion of uncultivated or fallow land is negligible across crops and sample farmers in the study area.

With regard to irrigation, in addition to the irrigated crops such as paddy and sugarcane, soybean also accounts for a major area (>90% each) under irrigation in respect of the sample crops and the remaining area is under rainfed conditions. Additionally, the area under maize and jute crop is also covered under irrigation to an extent of more than 72 per cent, whereas, tur is majorly grown under rainfed conditions both in the states of Karnataka and Maharashtra, and hence, the proportion of rainfed area constitutes more (71%) in the case of tur crop. However, about 29 per cent of the farmers also grow tur under irrigated conditions as well. It is noted that across

categories of farmers, a higher proportion of irrigated land is accounted for by small farmers followed by medium and large farmers in respect of almost all the irrigated crops.

The average rental value of leased-in land amounts to a maximum of Rs.15231/ acre for paddy followed by soybean (Rs.13639/ acre) and jute (Rs. 5696/ acre), while, it is less than Rs. 5000/ acre in the case of tur and sugarcane crops. At the same time, across categories, the rental value of leased-in land works out to a highest (Rs.18507/acre) for small farmers, followed by medium farmers (Rs. 14810/ acre) in respect of paddy, whereas, it is medium farmers (Rs. 14417/acre) followed by small farmers (Rs. 13300/ acre) in the case of soybean crops. Relatively, the same situation prevails with regard to over other crops. On the other hand, the rental value of leased-out land is slightly less than the value of leased-in land in the sample area. Similar to the rent value of leased-in land, the leased-out land value is highest in the case of paddy (Rs. 11916/ acre), followed by soybean (Rs. 11286/ acre). However, the leased-out land value of small farmers in the case of paddy is highest (Rs. 20294/ acre) as compared to the rental values of leased-in and leased-out land cross all crops. Interestingly, no sample farmers are found engaged in has across with no leasing-in and leasing-out activities in respect of maize and sugarcane crops, respectively.

Table 3.2a: Average operational landholding size of the sample farmers (Paddy, Tur and Sugarcane)

(Acres/Household)

Sl. No.	Particulars	Paddy				Tur				Sugarcane			
		Small	Medium	Large	Avg	Small	Medium	Large	Avg	Small	Medium	Large	Avg
1.	Own land	2.72	7.38	16.33	8.81	3.59	8.41	19.25	10.41	3.09	8.27	27.00	12.78
2.	Uncultivated/ Fallow	0.19	0.11	0.04	0.11	0.02	0.13	0.70	0.28	0.09	0.16	0.33	0.19
3.	Leased-in	0.23	1.32	5.22	2.25	-	0.09	0.55	0.21	-	0.20	-	0.06
4.	Leased-out	0.09	0.18	1.34	0.53	-	-	-	-	-	-	-	-
5.	Net Operational Area (1-2+3-4)	2.78	9.26	20.38	10.80	3.57	8.37	19.10	10.34	3.00	8.31	26.67	12.66
6.	% of irrigated land	86.85	92.51	91.32	90.22	34.18	27.23	26.65	29.35	94.50	83.28	92.85	90.21
7.	% of un-irrigated land	13.15	7.49	8.68	9.77	65.82	72.77	73.35	70.65	05.50	16.82	7.15	09.79
8.	Rental value of leased-in land (Rs/Acre)	18507	14810	12376	15231	2000	5017	4249	3755	-	1224	-	4080
9.	Rental value of leased-out land (Rs/Acre)	20294	8982	6474	11917	1750	-	4000	1917	-	-	-	-

Note: Farmers' classification: 0-5 acres - Small; 5-10 acres - Medium; more than 10 acres - large.

Source: Primary Survey

Table 3.2b: Average operational landholding size of the sample farmers (Maize, Soybean and Jute)

(Acres/Household)

Sl. No.	Particulars	Maize				Soybean				Jute			
		Small	Medium	Large	Avg	Small	Medium	Large	Avg	Small	Medium	Large	Avg
1.	Own land	2.94	7.53	20.80	10.42	2.67	5.76	14.74	7.72	2.75	6.06	12.40	7.07
2.	Uncultivated/ Fallow	0.01	0.06	-	0.02	-	0.07	0.24	0.10	0.11	0.25	0.33	0.23
3.	Leased-in	-	-	-	-	0.17	0.80	0.77	0.58	0.19	0.46	-	0.21
4.	Leased-out	0.06	0.21	1.00	0.75	0.02	-	-	0.01	0.12	0.18	1.74	0.68
5.	Net Operational Area (1-2+3-4)	2.87	7.27	19.80	9.70	2.82	6.49	15.27	8.19	2.71	6.09	10.33	6.37
6.	% of irrigated land	86.78	77.13	71.72	78.54	95.57	92.64	92.54	93.59	73.16	81.21	88.00	80.79
7.	% of un-irrigated land	13.22	22.87	28.28	21.45	4.43	7.36	7.46	6.41	26.84	18.79	12.00	19.21
8.	Rental value of leased-in land (Rs/Acre)	-	-	-	-	13300	14417	13200	13639	8100	8988	-	5696
9.	Rental value of leased-out land (Rs/Acre)	8261	6857	2800	5973	11286	-	-	11286	7917	8050	8667	8211

Note: Farmers' classification: 0-5 acres - Small; 5-10 acres - Medium; more than 10 acres - large.

Source: Primary Survey

3.3. Cropping pattern and Sources of irrigation

It is a normal practice that the cropping pattern followed by farmers depends upon the availability of irrigation, soil condition, and traditional agricultural practices and so on. In order to analyse the impact of NCU on production, productivity and soil health in India, it was worthwhile to study the cropping pattern adopted by farmers in general and reference crops, in particular. The cropping pattern details of reference crops are furnished in **Tables 3.3.1, 3.3.2 and 3.3.3**, respectively.

3.3.1. Cropping pattern followed by paddy farmers

Crops grown by paddy-farmers are shown in **Table 3.3.1**. The paddy-farmers across states grow crops like paddy, maize, cotton, basmati, sugarcane, fodder crops, vegetables and other crops such as pulses and oilseeds. It evident from the table that, large farmers account for as high as 76 per cent of the cropped area under paddy cultivation, followed by medium farmers (73%) and marginal and small farmers (59%). Whereas, other than paddy, marginal and small farmers also are found to be have allocated 15 per cent of their cropped area to cotton cultivation; 10 per cent to fodder crops during Kharif; nine per cent to maize and about five per cent to other crops such as pulses and oilseeds. This is a good practice followed by small and marginal farmers as part of being risk-averse and also from the view point of generating income from other sources such as dairy-farming and cultivation of commercial crops such as pulses and oilseeds. However, in the case of both the medium and large farmers, other crops are grown only for their own consumption.

Table 3.3.1: Cropping pattern adopted by paddy-farmers

(as % of total cropped area)

Sl. No.	Crops	Marginal & Small	Medium	Large
1	Paddy	58.77	72.58	75.51
2	Maize	8.87	4.75	2.40
3	Cotton	15.01	3.62	2.44
4	Basmati	1.16	4.59	8.40
5	Sugarcane	-	0.32	3.81
6	Kharif Fodder	9.51	7.41	4.77
7	Vegetables	1.22	1.90	0.30
8	Others	5.46	4.83	2.37
Total		100.00	100.00	100.00

3.3.2. Cropping pattern followed by tur-farmers

Table 3.3.2 presents the crops grown by tur-farmers. The tur-farmers in both states (Karnataka and Maharashtra) grow crops like tur, cereals, pulses, onion, cotton, fodder crops, oil seeds and other vegetables. It is evident from the table that tur crop is not grown as the sole crop by any of the categories of farmers across States. On the contrary, all of them have are engaged in the cultivation of oil seeds along with tur crop as major crops. Interestingly, a highest proportion (39% and 36%) of the gross cropped area is found under tur and oilseeds respectively, in the case of large farmers, whereas, in the case of medium farmers, a slightly higher gross cropped area (35%) is under oilseeds than tur (32%). With regard to small and marginal farmers, almost an equal proportion of area is under tur and oilseeds (29%). Further, as in the case of paddy-farmers, about 16 per cent of the gross cropped area is devoted to cereals and 14 per cent to cotton when it comes to small and marginal farmers. However, a relatively the same area (15-16%) is under other vegetables and 5-6 per cent under cereals in the case of medium and large farmers.

Table 3.3.2: Cropping pattern followed by tur-farmers

(as % of total cropped area)

Sl. No.	Crops	Marginal & Small	Medium	Large
1	Tur	29.17	31.78	38.80
2	Cereals	16.48	6.23	4.88
3	Pulses (other than tur)	3.78	2.08	1.60
4	Onion	3.56	-	-
5	Cotton	14.06	7.65	3.27
6	Oilseeds	29.39	35.35	35.92
7	Others	3.56	16.91	15.53
Total		100.00	100.00	100.00

3.3.3. Cropping pattern followed by sugarcane, maize, soybean and jute farmers

Crops such as sugarcane, maize, soybean and jute grown by respective farmers are shown in **Table 3.3.3**. It is interesting to note that none of the sugarcane-farmers cultivate paddy, maize, jute, soybean and Kharif vegetables, although, they have irrigation facilities. A large proportion of the gross cropped area belonging to small & medium farmers is under sugarcane, followed by medium farmers (59%) and large farmers (48%). Conversely, the next highest proportion of area is under cereals and horticultural crops. These sugarcane-farmers also grow oilseeds over an area that accounts for 10-14 per cent of the gross cropped area across different categories of farmers. Similarly, a negligible area is allocated to cotton and pulses.

Table 3.3.3: Cropping pattern followed by sugarcane, maize, soybean and jute farmers

(as % of total cropped area)

Sl. No.	Crops	Sugarcane			Maize			Soybean			Jute		
		Marginal & Small	Medium	Large	Marginal & Small	Medium	Large	Marginal & Small	Medium	Large	Marginal & Small	Medium	Large
1	Paddy	-	-	-	54.63	64.80	84.29	-	-	-	70.66	72.10	81.61
2	Maize	-	-	-	29.05	16.25	12.00	3.42	4.70	4.58	-	-	-
3	Cotton	4.10	2.9	0.60	-	-	-	15.21	21.60	19.66	-	-	-
4	Jute	-	-	-	-	-	-	-	-	-	26.88	18.79	11.18
5	Sugarcane	71.80	58.90	47.50	-	-	-	-	-	-	-	-	-
6	Soya bean	-	-	-	16.32	18.95	3.71	81.37	73.69	75.76	-	-	-
7	Kharif Vegetables	-	-	-	-	-	-	-	-	-	2.47	9.12	7.21
8	Pulses	1.40	1.40	0.40	-	-	-	-	-	-	-	-	-
9	Cereals	7.10	10.60	21.00	-	-	-	-	-	-	-	-	-
10	Oilseeds	10.1	14.00	12.00	-	-	-	-	-	-	-	-	-
11	Horticulture	5.5	12.20	18.60	-	-	-	-	-	-	-	-	-
Total		**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

A maximum of three crops are cultivated by maize, soybean and jute farmers across the study area. Excepting maize and jute, a maximum area is allocated to their respective reference crops only by the sample farmers. However, a substantial proportion (>55% and >70%) of the gross cropped area is allocated to paddy by both maize and jute sample farmers respectively, with the gross cropped area varying across groups of farmers. The large farmers grow paddy over an area of more than 82 per cent of the gross cropped area in the case of maize-farmers and jute-farmers. Similar is the case with medium farmers (65%) and marginal and small farmers (72%)

with respect to maize and jute-farmers, respectively. The reference crops (maize and jute) are given the second preference by these sample farmers and hence, the allocated area seems to be less. Within the groups, a maximum of 29 per cent of the gross cropped area is allocated to maize and 27 per cent of the GCA to jute by small and marginal farmers. The proportion is still less with regard to medium farmers (19% each of the gross cropped area), followed by large farmers (12 and 11 per cent) respectively. In addition, about 16 per cent and 19 per cent of the gross cropped area is also allocated to soybean by marginal and small farmers and medium farmers, respectively, while, this proportion is four per cent in the case of large farmers of soybean reference crop. On the other side, a less than 10 per cent of the gross cropped area is allotted to Kharif vegetables by jute-farmers. Regarding soybean sample farmers, a large proportion of the gross cropped area (>73%) is allotted to soybean alone across different groups, and at the same time, more than 15 per cent of them have undertaken cotton as the second important crop in terms of its area. However, a less than five per cent of the gross cropped area is devoted to maize crop by soybean-farmers.

3.3.4. Sources of irrigation

Irrigation is considered one of the foremost inputs in agriculture. Crop failures in many parts of India happen due to lack of a sufficient irrigation water. The major sources of irrigation in India include bore well, canal, well, tank, and open/dug irrigations. It can be seen from **Table 3.3.4** that bore wells (57%) form a major source of irrigation for different crops followed by open/ dug wells (32%), as revealed by the sample farmers in India at the aggregate level. Canal irrigation is the third important source of irrigation, as expressed by seven per cent of the farmers especially paddy, sugarcane and tur-farmers. About 11 per cent of the farmers also use more than one source for irrigating crops. On an average, about five per cent of the paddy and tur-farmers also dependent upon rainfall for their crop production. In addition, a negligible (<1%) of farmers use their tanks as a source of irrigation.

Bore-wells followed by canals are the major sources of irrigation for paddy, as revealed by 61 per cent and 29 per cent of the (paddy) farmers respectively. The situation seems to be different in the case of sugarcane with a majority of the farmers using (>64%) more than one sources of irrigation. Crops such as maize and jute are relatively dependent on bore-well as a source of irrigation, according to more than 94 per cent of the farmers. In the case of soybean, a majority of the farmers (76%) are dependent upon open/ dug wells and the rest are dependent on bore-wells only. Although tur is a dry-land crop, famers are generally dependent upon rainfall as a major source of irrigation. Nevertheless, due to an uneven distribution of rainfall, farmers nowadays irrigate this crop with the available sources of irrigation such as open/ dug wells (49% of farmers) and bore-wells (29% of farmers). However, about 28 per cent of the farmers are dependent upon rainfall as a source of irrigation for tur production.

Table 3.3.4: The sample farmers' sources of irrigation

(% Operational Area)

Sl. No.	Particulars	Paddy	Tur	Sugarcane	Maize	Soybean	Jute	Overall
1.	Open/ Dug well	05.80	48.80	47.20	14.00	75.50	00.00	31.88
2.	Bore well	60.50	29.20	33.20	94.50	24.00	100.00	56.90
3.	Canal	28.50	05.00	9.60	-	-	-	07.18
4.	Tank	01.20	00.95	1.00	-	-	-	00.52
5.	More than one source of Irrigation	00.60	01.20	64.30	-	0.50	-	11.10
6.	No Source of irrigation	03.40	28.00	-	-	-	-	05.23

3.4. Details of agricultural credit availed

3.4.1. Credit details of farmers by Paddy-farmers

Credit has been acting like a catalyst in the development of farm and non-farm sectors in the country since independence. Agricultural policies have been reviewed from time to time as part of providing an adequate and timely finance to this sector. The role of institutional credit has increased incredibly post economic liberalization in the country. The achievement to the target of agricultural credit flow in the country amounts to more than cent per cent since 2012-13, and particularly 106 per cent for 2014-15 (Ministry of Finance, Govt. of India, 2015).

Various institutional and non-institutional credit sources identified across the study area are given in **Table 3.4.1**. Overall, as discussed above, there is a good trend noticed in the study area in terms of growth of Institutional sources. It is observed from the table that the institutional sources (53%) dominate over the non-institutional sources (47%) in terms of credit availed of by paddy sample farmers. Among institutional sources, commercial banks seem to be the major source (19%) of lending to farmers, followed by land development banks (17%), cooperative banks (11%) and other Regional Rural Banks (RRBs) (6%). Whereas, within the non-institutional sources, money lenders and traders/ commission agents are the major sources of credit to paddy farmers with a relatively similar contribution (12-13% each). Friends and relatives constitute for about eight per cent of the credit availed. In addition to these, the other sources such as fellow farmers, political leaders, labour contractors etc., together lend credit to an extent of 14 per cent to the farmers for both agricultural and non-agricultural purposes though with a high rate of interest at the aggregate level. On an average, farmers are found to have availed of Rs. five lakh per household from both the institutional and non-institutional sources with the share of non-institutional sources being the highest.

Table 3.4.1: Credit details of Paddy-farmers (for the reference period)

Sl. No.	Sources	% Amount availed					Overall	
		Karnataka	Bihar	Punjab	Madhya Pradesh	Assam	Value Rs./hh	% Amount availed
Institutional sources								
1	Commercial Banks	13.16	82.12	55.71	60.86	20.65	95894	19.14
2	Co-operative societies and	7.08	3.07	31.62	34.55	59.64	52818	10.54
3	Regional Rural Banks	7.22	2.31	-	3.03	19.70	31417	6.27
4	Land development banks	19.73	-	-	-	-	85000	16.97
Non-Institutional sources								
5	Money lenders	13.62	12.50	-	1.55	-	58844	11.74
6	Friends & relatives	9.50	-	1.24	-	-	41718	8.36
7	Traders / commission agents	13.62	-	11.43	-	-	65979	13.17
8	Others	16.06	-	-	-	-	69200	13.81
Total		100.00	100.00	100.00	100.00	100.00	500809	100.00

The share of institutional credit varies across States. The institutional share is found substantial (100%) in the case of Assam, followed by Madhya Pradesh (98%), Bihar (88%) and Punjab (87%). However, in the case of Karnataka, this proportion is less than 50 per cent. Among the institutional sources, commercial banks have played an important role, especially in Bihar (82%), followed by Madhya Pradesh (61%) and Punjab (55%), while, the share of cooperative societies amounts to 60 per cent in the case of Assam. Further, cooperative societies have also disbursed about 32 per cent and 35 per cent of the credit to paddy-farmers in Punjab and Madhya Pradesh, respectively. The commercial banks and RRBs accounts for 20 per cent each in respect of Assam, in addition to the commercial banks. However, with respect to Karnataka, land development banks account for more than half of the share (20%) from among the institutional sources; however, these banks are not at all active in other States. The commercial banks constituted about 13 per cent of the credit availed of by farmers in Karnataka, followed by cooperative societies and RRBs (7% each).

The contribution of money lenders, and traders/ commission agents is found highest across non-institutional sources in almost all the sample States. Both these sources constituted equally 14 per cent each in terms of credit disbursement to the farmers of Karnataka, followed by friends and relatives (10%) and other sources (16%). Whereas, in the case of Bihar, money lenders are the only non-institutional sources of finance accounting for about 13 per cent of the credit availed of by the farmers. On the other hand, traders/ commission agents are the chief (11%) source of non-institutional finance in the case of Punjab, followed by friends and relatives with

an insignificant contribution. In Madhya Pradesh, only about two per cent of the credit is found disbursed by money lenders from among the non-institutional sources. Interestingly, none of the farmers in Assam is found to have availed of credit from non-institutional sources.

3.4.2. Purpose behind borrowing loans by Paddy-farmers

The purpose behind borrowing loans by the sample households is shown in **Table 3.4.2**. Overall, seasonal crop cultivation (56%) is the main purpose behind borrowing loans by paddy-farmers. However, about 29 per cent of the farmers have not revealed the purpose for which they had availed of loans. About six per cent of the paddy farmers are found to have availed of credit for multiple purposes and four per cent for consumption purposes.

Across all the sample States also, seasonal crop cultivation appears to be the main reason for borrowing loans. This proportion is as high as 82 per cent in the case of Punjab, followed by 70 per cent in Karnataka and 67 per cent in Madhya Pradesh. As per about nine per cent of the farmers from Bihar and Assam, seasonal crop cultivation is the motive behind their availing of loans. However, in the case of Karnataka, the other major reasons cited by paddy-farmers include purchase of tractors (9%), consumption purpose (6%) and other expenditures etc. With respect to Punjab, about 18 per cent farmers are found to have availed of loans for more than one purposes. Consumption expenditure is the second important reason behind farmers borrowing loans as expressed by ten per cent of the farmers from Madhya Pradesh. A majority of about 91 per cent of the farmers from Assam, 86 per cent from Bihar and 19 per cent from Madhya Pradesh have not revealed the reasons behind availing of loans.

Table 3.4.2: Purpose behind borrowing loans by paddy-farmers (for the reference period)

(% Farmers)

Sl. No.	Purpose	Karnataka	Bihar	Punjab	Madhya Pradesh	Assam	Overall
1	Seasonal crop cultivation	70.13	09.00	82.31	66.50	09.50	56.39
2	Purchase of tractor and other implements	08.77	-	-	01.00	-	02.29
3	Purchase of livestock	01.19	-	-	02.00	-	00.67
4	Consumption expenditure	05.58	02.00	-	09.50	-	03.53
5	Marriage and social ceremonies	02.78	01.00	-	-	-	00.85
6	Non-farm activity	00.79	-	-	-	-	00.19
7	Other expenditure	03.19	02.00	-	02.00	-	01.52
8	More than One purposes	02.39	-	17.69	-	-	05.52
9	No response/ Blank	05.18	86.00	-	19.00	90.50	29.04
Total		**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

3.4.3. Credit details of Tur-farmers

Various institutional and non-institutional credit sources identified across the tur study area are given in **Table 3.4.3.** Overall, like paddy farmers, institutional sources (81%) dominate over the non-institutional sources (19%) in terms of lending credit to the tur sample farmers. Overall, among institutional sources, commercial banks (39%) account for a major share of credit lent to farmers followed by land development banks (22%), cooperative banks (15%) and other regional rural banks (5%), whereas, among the non-institutional sources, private money lenders (6%) and friends and relatives (5%) are found to have played an important role in the disbursement of loans to the farmers and traders/ commission agents accounted for a very meagre share (<1%). The other sources such as fellow farmers, political leaders, labour contractors etc., have also contributed significantly (8%), especially in the case of Karnataka. On an average, tur farmers have availed of credit of up to Rs. 9.36 lakh/ household.

As regards both the sample states, across institutional sources, the contribution of commercial banks is found substantial in the case of Maharashtra (68%), followed by land development banks in Karnataka (45%). Similarly, cooperative societies have contributed to an extent of 26 per cent of credit in the case of Maharashtra whereas, commercial banks have disbursed loans to an extent of 11 per cent in Karnataka. The role of RRBs seems to be minimum in both the States.

Table 3.4.3: Credit details of farmers by Tur-farmers (for the reference period)

(Rs per household)

Sl. No.	Sources	% Amount availed		Overall	
		Karnataka	Maharashtra	Value (Rs/ hh)	% Amount availed
Institutional sources					
1	Commercial Banks	10.50	67.60	124026	39.05
2	Co-operative societies and	3.16	26.00	40010	14.58
3	Regional Rural Bank	6.23	03.50	57095	4.86
4	Land development bank	44.87	-	400000	22.43
Non-Institutional sources					
5	Money lenders	8.78	02.60	79425	5.69
6	Friends & relatives	9.07	-	80833	4.55
7	Traders/commission agent	1.96	-	17500	0.98
8	Others	15.43	00.09	137543	7.76
Total		**100.00**	**100.00**	**936432**	**100.00**

3.4.4. Purpose behind borrowing loans by Tur-farmers

The purpose behind borrowing loans by tur sample households is shown in **Table 3.4.4**. Overall, seasonal crop cultivation (74%) is the main purpose behind borrowing of loans by tur-farmers, followed by purchase of tractor and other implements (10%) and consumption expenditures (7%), whereas, a few farmers (4%) are found to have availed of loans for more than one purposes. At the same time, very meagre proportion (<5%) of the farmers is observed to have taken loans for organizing marriage and social ceremonies followed by non-farm activities and other personal purposes.

Table 3.4.4: Purpose behind borrowing loans by Tur-farmers (for the reference period)

(% farmers)

Sl. No.	Purpose	Karnataka	Maharashtra	Overall
1	Seasonal crop cultivation	75.13	73.12	74.12
2	Purchase of tractor and other implements	2.20	18.37	10.29
3	Purchase of livestock	1.10	00.22	0.66
4	Consumption expenditure	6.62	8.29	7.46
5	Marriage and social ceremonies	4.97	-	2.48
6	Non-farm activity	1.10	-	0.55
7	Other expenditure	1.10	-	0.55
8	More than One purposes	7.78	-	3.89

Across states, it is also observed that seasonal crop cultivation is the key purpose for borrowing in Karnataka and Maharashtra, as revealed by more than 73 per cent each of tur-farmers. Purchase of tractor and other implements is the second most important reason (18%) in the case of Maharashtra. More or less the same proportion (7-8%) of farmers has expressed that they had availed of loans for consumption expenditures in both the States. However, about eight per cent of the farmers are found to have availed of credit for more than one purposes, followed by five per cent of them for organizing marriage and social ceremonies in the case of Karnataka.

3.4.5. Credit details of sugarcane, maize, soybean and jute farmers

Both institutional and non-institutional credit sources identified for sugarcane, maize, soybean and jute across study area are given in **Table 3.4.5**. It is understood from the table that cent per cent of sugarcane farmers in Maharashtra had opted for institutional sources of finance from among the institutional sources, a majority (78%) had availed of credit from cooperative societies and the rest (22%) from commercial banks. In the case of Bihar, a majority of (79%) maize farmers had borrowed loans from institutional sources and the rest from non-institutional

sources. From among the institutional sources, more than half of the farmers (55%) preferred commercial banks, followed by cooperatives (16%) and RRBs (8%).

Similarly, a majority of soybean-farmers (86%) in Madhya Pradesh also had opted for institutional sources for availing of credit. Of which, about 46 per cent had chosen commercial banks, followed by cooperative banks (34%) and RRBs (6%). From among the non-institutional sources, about seven per cent had taken loans from friends and relatives, four per cent from money lenders and three per cent from traders/ commission agents in the case of soybean from Madhya Pradesh. Corresponding to sugarcane farmers of Maharashtra, jute farmers in Assam also had opted for institutional sources of finance only, wherein, a majority had gone for cooperatives banks (62%) as compared to commercial banks (23%) and RRBs (15%).

Table 3.4.5: Credit details of sugarcane, maize, soybean and jute farmers (for the reference period)

(Rs per household)

Sl. No.	Sources	% Amount availed			
		Maharashtra	Bihar	Madhya Pradesh	Assam
Institutional sources					
1	Commercial Banks	22.00	55.13	45.93	22.90
2	Co-operative societies and	78.00	16.13	34.12	61.79
3	Regional Rural Bank	-	8.16	6.43	15.31
Non-Institutional sources					
4	Money lenders	-	20.69	3.56	-
5	Friends & relatives	-	-	6.99	-
6	Traders/commission agent	-	-	2.93	-
Total		100.00	100.00	100.00	100.00

3.4.6. Purpose behind borrowing loans by sugarcane, maize, soybean and jute farmers

The reasons for borrowing loans by sugarcane, maize, soybean and jute households are presented in Table 3.4.6. Overall, as usual, a majority of sugarcane farmers (84%) in Maharashtra and soybean farmers in Madhya Pradesh (86%) have reported seasonal crop cultivation as foremost purpose behind borrowing loans from different sources. On the other hand, a majority of maize and jute farmers from Bihar (85%) and Assam (93%) respectively, have not revealed the purpose behind availing of credit from different sources. However, other reasons cited by less than 10 per cent of the farmers from each category include purchase of tractor and other implements, purchase of livestock, consumption expenditures etc., for borrowing loans.

Table 3.4.6: Purpose behind borrowing loans by sugarcane, maize, soybean and jute farmers for the reference period

(% farmers)

Sl. No.	Sources	Maharashtra	Bihar	Madhya Pradesh	Assam
1	Seasonal crop cultivation	84.00	9.00	85.83	07.50
2	Purchase of tractor and other implements	9.00	-	5.00	-
3	Purchase of livestock	1.50	0.00	5.00	-
4	Consumption expenditure	2.00	2.00	2.50	-
5	Marriage and social ceremonies	-	2.00	-	-
6	Non-farm activity	-	-	1.67	-
7	Other expenditure	-	2.00	-	-
8	No response/ Blank	3.50	85.00	-	92.50
Total		100.00	100.00	100.00	100.00

3.5. Summary of the chapter

A majority of sample farmers across reference crops are males, with an average family size of seven members, out of which three are engaged in farming with an experience of 24 years. At the aggregate level, the sample farmers are educated within Pre-University. More than half of them belong to general category followed by Other Backward Classes (OBCs) (29%), followed by Scheduled Castes and Tribes. This proportion is relatively same as that of reservation system followed by the Indian government. The net operational area in the study region is comparatively more in the case of sugarcane farmers, followed by paddy and tur-farmers. As usual, the highest operational land is with the large farmers in respect of all the sample crops. With regard to irrigation, in addition to irrigated crops such as paddy and sugarcane, soybean also accounts for a major area share (>90% each) under irrigation among sample crops and the remaining area is under rainfed conditions. However, a higher proportion of irrigated land is found among small farmers, followed by medium and large farmers in respect of almost all the irrigated crops. The cropping pattern followed by sample farmers reveals that the crops like paddy, maize, cotton, basmati, sugarcane, fodder crops, vegetables and other crops such as pulses and oilseeds are the reference crops. It is noticed from the field study that the reference crops such as maize and jute are given the second preference by the sample farmers in the homestead area, and hence, the allocated area seems to be less in respect of these crops. Interestingly, none of the sugarcane-farmers is found cultivating paddy, maize, jute, soybean and Kharif vegetables, despite having irrigation facility. A maximum of three crops are cultivated by the maize, soybean and jute farmers across the study area.

It is found that small and marginal farmers have undertaken various other activities such as dairy-farming and growing commercial crops such as pulses and oilseeds as part of being risk-

averse and also for generating an additional income. Bore wells (57%) form a major source of irrigation for different crops followed by open/ dug wells (32%), as revealed by the aggregate sample farmers, while, canal irrigation is the third important source of irrigation as expressed by few paddy, sugarcane and tur-farmers. In the case of soybean, a majority of the farmers (76%) depend on open/ dug wells and the rest are irrigated by bore-wells only. Although tur is a dry-land crop, farmers generally depend upon rainfall as their major source of irrigation. It is also evident from the study that the institutional sources (53%) dominate over non-institutional sources (47%) in terms of credit lent to all the sample farmers. Among institutional sources, commercial banks, followed by cooperatives are the major sources of finance in the study region, whereas, with regard to non-institutional sources, money lenders and traders/ commission agents are the major sources of credit to the sample farmers. Overall, seasonal crop cultivation (56%) is the main purpose behind borrowing from different sources, as expressed by a majority of the farmers.

Neem Coated Urea fertilizer used in paddy field, Davanagere district, Karnataka

4. Status of Awareness and Application of Neem Coated Urea

Although both the state and central governments have initiated steps towards creating awareness among farmers regarding the utility of NCU before distribution across states, a majority of the farmers are not able to identify and differentiate between NU and NCU.

Therefore, to understand the level of awareness among the farming community in the study area, the following information was sought and the results are discussed in detail under this chapter as follows:

4.1. Awareness and sources of information on NCU

4.2. Purchasing pattern and sources of purchase of NCU and NU

4.3. Status of application of NU relative to NCU

4.4. Perceptions of farmers regarding NCU and its benefits as compared to NU

4.5. Usage of inputs and profitability of the reference crops

4.6. Diversion of NU/ NCU to other than crop production

4.7. Constraints and suggestions regarding NCU and its adoption

4.1. Awareness and sources of information on NCU

4.1.1. 1. Awareness and sources of information on NCU among paddy-farmers

The awareness and sources of information about NCU among farmers of paddy crop in the study area are presented in **Table 4.1.1.1** and **Figure 4.1.1.1** It is revealed from the table that, overall, about 90 per cent of the farmers are aware of NCU. However, across states, the awareness level is much higher in Bihar (99.50%), followed by Punjab (98.50%) and Madhya Pradesh (94.50%) as compared to the aggregate level. The awareness is much lower in the case of paddy farmers in Karnataka (67%) as compared to Assam (89 per cent).

Table 4.1.1.1: Awareness status and sources of information on NCU with regard to paddy-farmers

Sources of Information	Punjab	Karnataka	Madhya Pradesh	Assam	Bihar	Overall
% of farmers being aware of NCU use	98.50	67.00	94.50	89.00	99.50	90.10

With regard to sources of awareness (**Figure 4.1.1.1**), overall, input suppliers/ cooperatives (43%) are a major source of information for farmers followed by agricultural officers (19%). About 17 per cent of the farmers are found to have got the information from their fellow farmers. Similarly, across states also a major source of information appears to be input suppliers/ cooperatives. In the case of Punjab, as high as 90 per cent of the farmers have reported that they had come to know of NCU from input suppliers/ cooperatives followed by Bihar (60%) and Assam (45%) farmers. Input suppliers are the major source of information on NCU for about 22 per cent of the farmers in Karnataka. As usual, agricultural officers from the respective State Department of Agriculture are the second important source of awareness for paddy-farmers of Madhya Pradesh (65%) and Karnataka (20%). While for about 24-26 per cent of the farmers from Assam and Madhya Pradesh their fellow farmers are the major source. Interestingly, about 29 per cent of the farmers in Karnataka have reported other sources such as friends and relatives, companies and KVKs with regard to the creation of awareness regarding utility of NCU. Other than these sources, print and visual media, agricultural universities and farmer facilitators have also contributed to some extent.

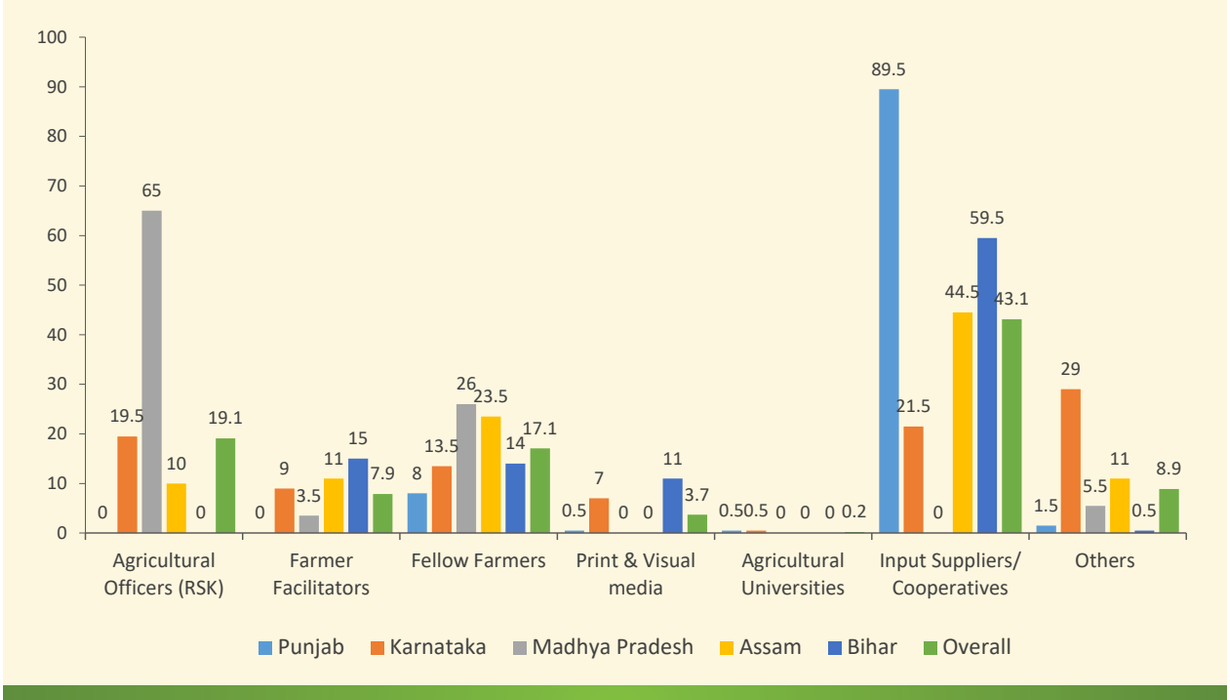


Figure 4.1.1.1: Sources of information on NCU with regard to paddy-farmers

The results indicate that a large proportion of the farming community continuous to be unaware of NCU use in the study area across, the reference crops despite the presence of varied sources. Nevertheless whether farmers are aware or not aware of NCU use, special efforts are needed for creating awareness regarding the potential benefits of NCU usage vis-a-vis NU among the farming community, considering that the government has made mandatory production of NCU (100 %) since, May 2015.

4.1.2. Awareness and sources of information on NCU with regard to tur-farmers

The awareness and sources of information about NCU among tur-farmers in the study area are presented in **Table 4.1.1.2** and **Figure 4.1.1.2**. It is observed from the table that, overall, only 27 per cent of the farmers are aware of NCU use. However, across states, the awareness level is much higher (42%), among tur-farmers in Maharashtra as compared to their counterpart in Karnataka (12%). This might be due to dryland cultivation followed by farmers in the case of tur-crop, with a majority of them hardly applying any chemical fertilizers, although few farmers having access to irrigation are found to have applied all fertilizers. Moreover, tur has a nitrogen fixation property in the soil and hence, the urea requirement for the crop is negligible.

With regard to sources of awareness (**Figure 4.1.1.2**), overall the officials of State Department of Agriculture (i.e., agricultural officers) (31%), followed by fellow farmers (28%) are the major sources of information to tur-farmers, however, across States, a similar trend is noticed in Karnataka, with 49 per cent of the farmers coming to know of NCU use from the officials of the State Department of Agriculture (SDA), followed by fellow farmers (28%) and farmer facilitators (14%), whereas, in the case of Maharashtra, major sources of information happens to be fellow farmers (32%), followed by input suppliers/ companies (25%), farmer facilitators (21%) and the officials of SDA (13%). However print and visual media have contributed to a negligible extent.

Table 4.1.1.2: Awareness status and sources of information on NCU with regard to tur- respondents

Sources of Information	Karnataka	Maharashtra	Overall
% of farmers being Aware of NCU use	12.00	42.00	27.00

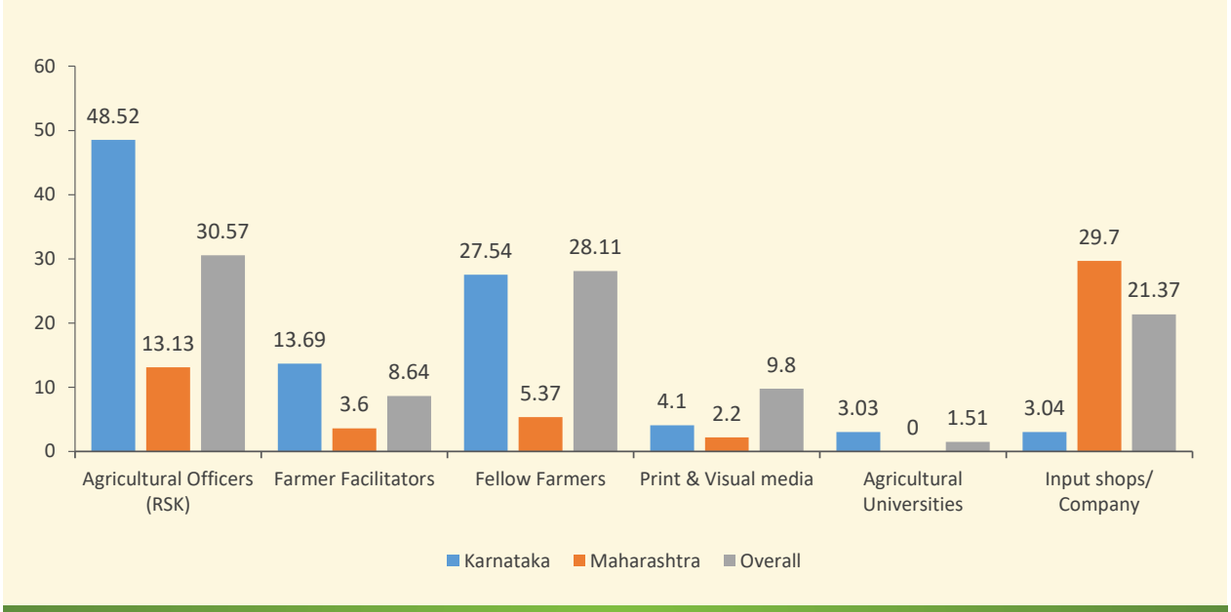


Figure 4.1.1.2: Sources of information on NCU with regard to tur/redgram-farmers

4.1.3. Awareness and sources of information on NCU with respect to maize, sugarcane, soybean and jute farmers in different states

The, details of awareness and sources of information on NCU with regard to farmers of maize, sugarcane, soybean and jute crops in the study area are presented in **Table 4.1.1.3** and Figure **4.1.1.3**. It is noticed from the table that, the awareness level is cent per cent, 83 per cent and almost 70 per cent each among maize-farmers in Bihar, jute-farmers in Assam, and sugarcane and soybean-farmers in Maharashtra and Madhya Pradesh, respectively.

With regard to sources of awareness (**Figure 4.1.1.3**), input suppliers, have acted as a major (47%) source of information for maize-farmers in Bihar, followed by print and visual media (23%), fellow farmers (18%) and farmer facilitators (12%), whereas, in the case of sugarcane-farmers in Maharashtra, agriculture officers are the major source (48%), followed by input suppliers/ cooperatives (43%). On the contrary, farmer facilitators are a major source of information (59%) among soybean farmers in Madhya Pradesh. For about 25 per cent, of the soybean- farmers from the SDA officials are the source. However, with respect to jute farmers in Assam, input suppliers/ cooperatives (36%) have played a key role in educating farmers regarding NCU use followed by fellow farmers (27%), other sources such as agricultural universities, company suppliers, friends and relatives (18%).

Table 4.1.1.3: Awareness status and sources of information on NCU with respect to Maize, Sugarcane, Soybean and Jute farmers

Sources of Information	Maize	Sugarcane	Soybean	Jute
	Bihar	Maharashtra	Madhya Pradesh	Assam
% of farmers being Aware of NCU use	100.00	69.50	69.28	82.50

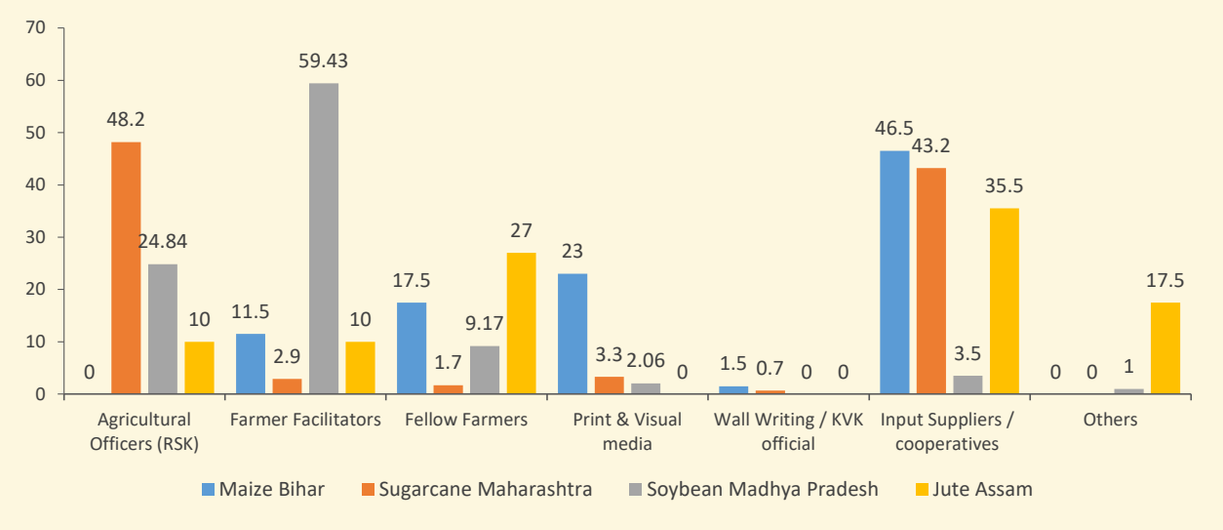


Figure 4.1.1.3: Sources of information on NCU with regard to Maize, Sugarcane, Soybean and Jute farmers

Although farmers are aware of NCU, a majority of them might be ignorant about the potential benefits of NCU usage relative to NU. Hence, special efforts are needed on the part of all States with regard to all crops in general, and tur and soybean crops in particular, especially its more so in case of Maharashtra and Madhya Pradesh, where about 30 per cent of the farmers are do not aware of NCU.

4.1.2. Factors which help differentiate between NCU and NU

4.1.2.1. Factors which help paddy, tur and sugarcane farmers differentiate between NCU and NU

The factors which help paddy, tur and sugarcane farmers differentiate between NCU and NU are presented in **Table 4.1.2.1**. It is noticed from the table that more than 77 per cent of paddy-farmers from all categories are able to identify the difference between NCU and NU, whereas, in the case of tur-farmers, relatively half of them from all categories are able to notice the difference between NCU and NU. Interestingly, almost all sugarcane-farmers, irrespective of categories are able to identify the difference between NCU and NU.

It is implicit that the colour, leaf figure on the bag and price difference (higher price) are the major factors that help farmers differentiate between NCU and NU. It is noticed that more than one factor have helped them differentiate between NU and NCU in almost all the States. Across the sample States, a majority of the paddy-farmers are reported to have identified NCU based on the leaf figure on the bag. However, the proportion of farmer groups having noticed the difference based on the leaf figure on the bag is highest among medium farmers (52%), followed by small (49%) and large farmers (42%). According to about 275 to 33% of paddy-farmers, it's the NCU colour that helps them differentiate between NCU and NU.

Similarly, as per about 53 per cent of medium farmers, 32 per cent of large farmers and 14 per cent of small farmers in the case of tur, it is leaf figure that helps them identify NCU. Apart from this, a majority (68 per cent) of the large farmers and 47 per cent of the small farmers also have reported that more than one factors help them differentiate between NCU and NU. Price-difference is the other important factor which helps tur-farmers distinguish NCU from NU (43 per cent of medium farmers).

Correspondingly, sugarcane-farmers are able to notice the difference between NCU and NU on the basis of more than one factors (more than 60 per cent from each category). Interestingly, none of the sugarcane farmers have stated leaf figure on the bag as the factor that helps them differentiate between NCU versus NU. Does not vanish easily has been also expressed by 22 per cent of the small farmers and rest of the factors by a few farmers from small and medium categories.

Table 4.1.2.1: Factors which help farmers differentiate between NCU and NU with respect to paddy, tur and sugarcane crops

Sl. No.	Sources of Information	Paddy			Tur			Sugarcane		
		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
	% of farmers being able to notice the difference between NCU and NU	76.62	80.62	82.70	51.75	52.75	51.75	99.2	100	100
Factors which help farmers differentiate between NCU and NU (% of farmers)										
1	Colour difference	26.63	27.21	32.8	35.71	-	-	12.7	4.40	-
2	Price difference	15.10	21.20	7.45	-	43.25	-	4.90	-	-
3	Leaf figure on the bag	48.67	51.59	41.88	14.28	53.20	31.68	-	-	-
4	More than one factors	1.14	-	17.40	46.75	-	68.32	60.00	95.60	100.00
5	Any other (Specify) Does not vanish easily	8.79	-	0.47	3.25	3.55	-	22.40	-	-
6	Others (Blank/ No response)	26.63	27.21	32.8	35.71	-	-	12.7	4.40	-

The factors which help maize, soybean and jute farmers presented in Table 4.1.2.2. As compared to paddy and tur farmers, a majority of the farmers differentiate between NCU and NU are in the case of sugarcane, maize, soybean and jute crops are able to find the difference between NCU and NU. From the table, it is very clear that excepting, small farmers with reference to jute crops, more than 90 per cent each of maize, soybean and jute farmers from all categories have been able to notice the difference between NCU and NU. The small farmers proportion in the case of jute crop is also not less than 80 per cent in terms of differentiate between NCU and NU.

Table 4.1.2.2: Factors which help farmers differentiate between NCU and NU in the case of maize, soybean and jute crops

Sl. No.	Sources of Information	Maize			Soybean			Jute		
		Small	Medium	Large	Small	Medium	Large	Small	Medium	Large
	% of farmers being able to notice the difference between NCU and NU	89.89	94.12	100.00	96.43	91.18	89.47	79.65	100	100
Factors which help farmers differentiate between NCU and NU (% of farmers)										
1	Colour difference	-	-	-	25.00	20.59	15.79	64.23	84.62	50.00
2	Price difference	21.25	0.00	20.00	29.76	29.41	10.53	13.87	3.85	-
3	Leaf figure on the bag	43.13	18.75	60.00	45.24	50.00	73.68	21.90	11.54	50.00
4	More than one source	35.62	81.25	20.00	-	-	-	-	-	-

Regarding the factors, a majority of maize-farmers (81% of medium, 36% of small and 20% of large farmers) have reported that they are able to differentiate between NCU and NU more than one factors. The second important factor is the leaf figure on the bag, as expressed by about

60 per cent of the large farmers followed by 43 per cent of small farmers and 19 per cent of medium farmers. The price difference is the third important factor, as noticed by about 20 per cent each of the small and large maize-farmers.

With respect to soybean farmers, more than 45 per cent each of the farmer groups have reported that leaf figure on the bag as the key factor in identifying NCU from NU, followed by colour and price-difference. On the other hand, more than 50 per cent of the large farmers, 85 per cent of the medium farmers and 64 per cent of the small farmers have cited colour difference as the foremost factor followed by leaf figure on the bag in differentiate between NCU and NU in the case of jute.

4.1.3. Training programmes attended on fertilizer application

4.1.3.1: Training/s attended by paddy-farmers with respect to the application of fertilizers

The details of training and sources of training with respect to the application of fertilizers by farmers of paddy crop in the study area are presented in **Table 4.1.3.1** and **Figure 4.1.3.1**. It is revealed from the table that overall, about 21 per cent of paddy-farmers had attended training programmes in the selected States. However, across states, the proportion of farmers attending training programmes is highest in the case of Assam (89%) followed by Punjab (70%), Madhya Pradesh (28%) and Karnataka (9%). None of the paddy-farmers in Bihar attended trainings. Overall, the SDA/ Horticulture are a major source of training for farmers on fertilizer applications across the sample States. However, a majority of the farmers were not able to explain the details of (79%) trainings organized and attended (i.e., in terms of who, where and when).

Similarly, across States, the Department of Agriculture/ horticulture is a major source of training, as expressed by a majority of the farmers in Punjab (63%), followed by Madhya Pradesh (28%). In Karnataka, about five per cent of the farmers have reported RSKs as the major source of training followed by SDA (3%). About seven per cent of paddy-farmers in Punjab also have stated that they had attended trainings organized by Agricultural Universities. A majority of the farmers from all States have not responded to this question may be due to their ignorance or failure to recollect.

Table 4.1.3.1: Training/s attended by respondents with respect to the application of fertilizers in the case of paddy crop

(% farmers)

Name of the Organizer	Punjab	Karnataka	Madhya Pradesh	Assam	Bihar	Overall
% of farmers attended training programmes	70.00	09.00	28.00	89.00	-	21.40

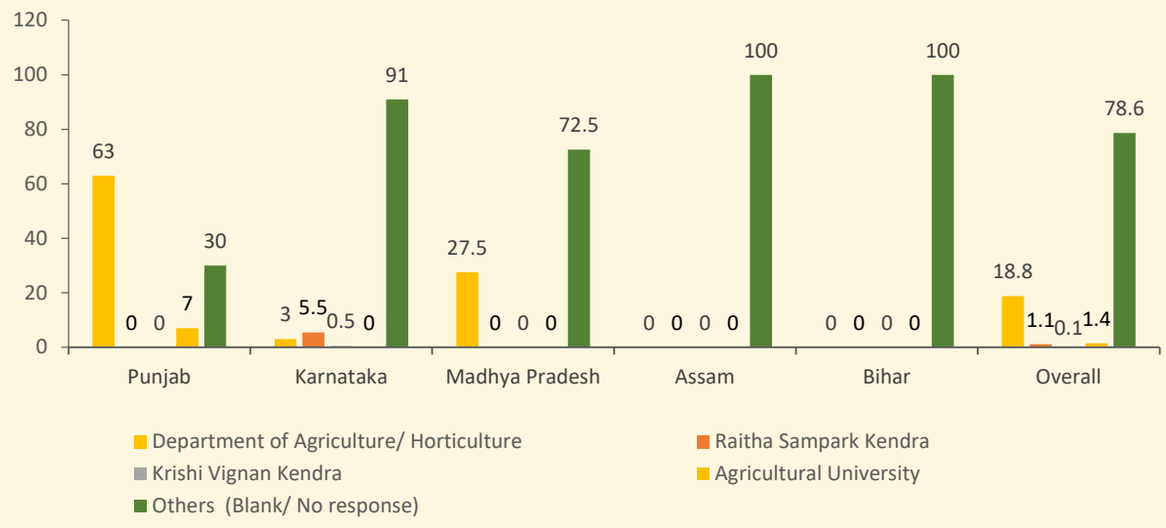


Figure 4.1.3.1: Training/s attended by the respondents with respect to the application of fertilizers in the case of paddy crop

4.1.3.2: Training/s attended by tur-farmers with respect to the application of fertilizers

The details of training and sources of training related to application of fertilizers by farmers of tur crop in the study area are illustrated in **Table 4.1.3.2**. It is revealed from the table that, overall, about only six per cent of the tur-farmers has undergone training programmes. However, a maximum of ten per cent of tur-farmers from Maharashtra and four per cent from Karnataka have attended the training programmes. With regard to sources of training, like in the case of paddy-farmers, a majority of the farmers (74%) are found to have attended trainings organized by the Department of Agriculture/ Horticulture. Similarly, across States, a majority of the farmers (67% of Karnataka and 81% of Maharashtra farmers) had attended trainings organized by the Department of Agriculture/ Horticulture. The RSKs reported by Karnataka tur-farmers (33%) are also part of the Department of Agriculture. However, KVKs, Rashtriya Chemical Fertilizers and Reliance-NGOs are also the centers where, tur-farmers from Maharashtra had attended the trainings on fertilizer application, as expressed by (six per cent each). Excepting KVKs, others are the private fertilizer companies in Maharashtra.

Table 4.1.3.2: Training/s attended by tur-farmers with respect to the application of fertilizers

(% farmers)

Name of the Organizer	Karnataka	Maharashtra	Overall
% of farmers attended training programmes	3.50	9.50	6.00

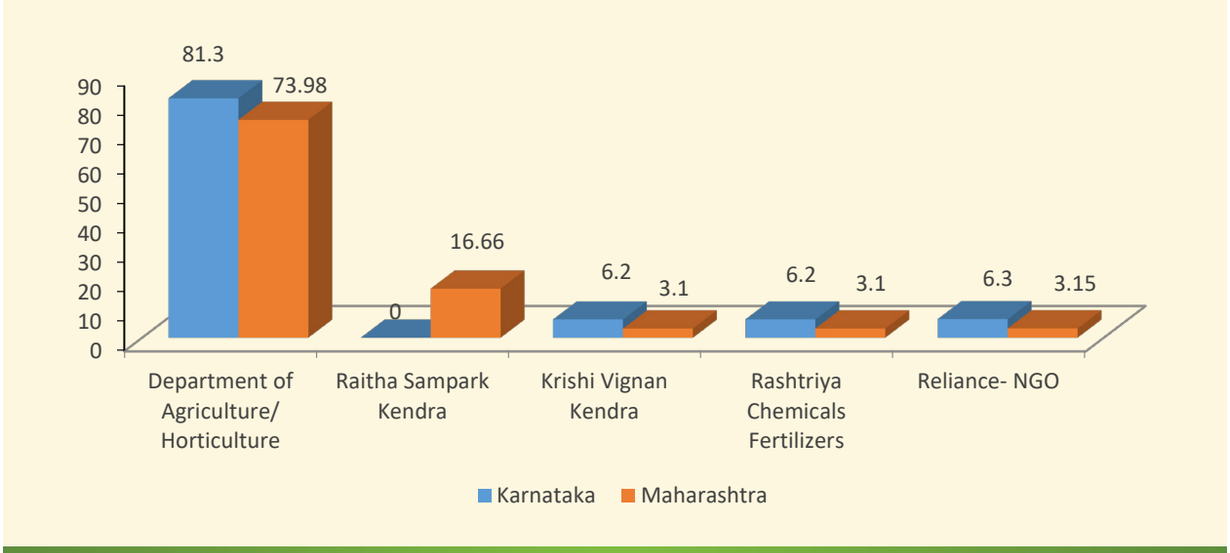


Figure 4.1.3.2: Training/s attended by tur-farmers with respect to the application of fertilizers (% of farmers)

4.1.3.3: Training/s attended by sugarcane and soybean farmers with respect to the application of fertilizers

The details training and sources of training related to the application of fertilizers by farmers of sugarcane and soybean are presented in **Table 4.1.3.3**. It is revealed from the table that only 24 per cent of sugarcane-farmers in Maharashtra and 19 per cent of soybean-farmers in Madhya Pradesh have attended training programmes on fertilizer application, while none of the maize-farmers from Bihar and jute-farmers from Assam are found have attended trainings on fertilizer application.

With regard to sources of training, as usual, the department of agriculture is the major source both in the case of sugarcane (80%) and soybean (28%). Apart from this, ten per cent and about five per cent each of the farmers are found to have undergone trainings organized by Rashtriya Chemical Fertilizers and KVKs / Primary Agricultural Cooperative Societies, respectively, in Maharashtra. However, a majority of the (72%) soybean-farmers in Madhya Pradesh failed to recollect the sources of training.

Table 4.1.3.3: Training/s attended by sugarcane and soybean farmers' respondents with respect to the application of fertilizers

Name of the Organizer	Maharashtra	Madhya Pradesh
	Sugarcane	Soybean
% of farmers who had attended training programmes	24.25	18.50

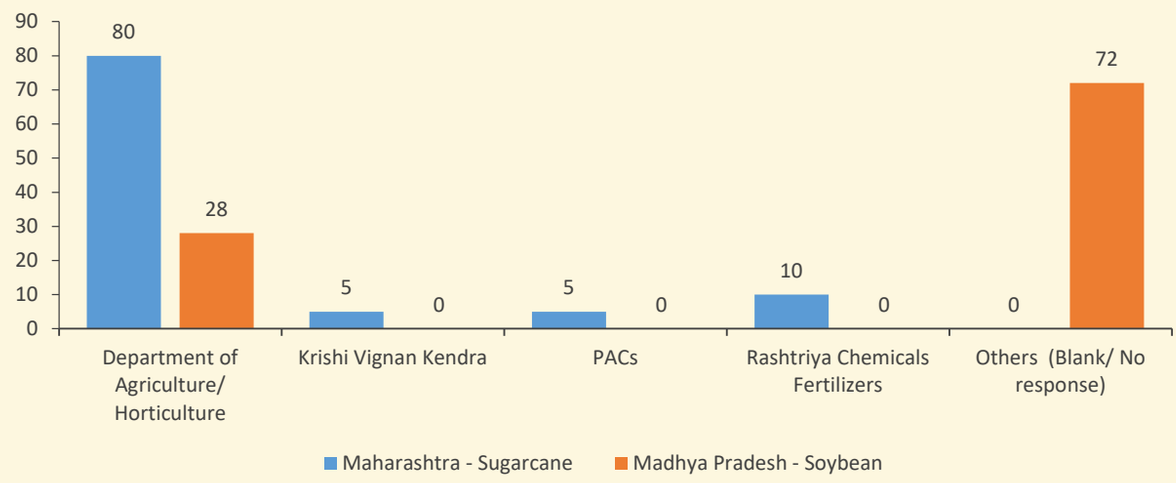


Figure 4.1.3.3: Sources of training/s for the application of fertilizers in the case of Sugarcane and Soybean (% of farmers)

4.2. Purchasing pattern of NCU and NU fertilizers

4.2.1.1. Purchasing pattern of NCU and NU by paddy-farmers

The details of purchase pattern of NCU and NU fertilizers are presented in **Table 4.2.1.1**. The table gives a comparative picture of the usage of NU and NCU fertilizers in respect of paddy crop. Overall, farmers account for a higher quantity (463 kg/ household) of NCU purchased as compared to NU users (215 kg/ household), with the average price of NCU, purchased being Rs.256/- per 50 kg bag, which is slightly higher as compared to NU (Rs.204/- per 50 kg bag). Although the incremental cost on neem coating works out to less than Rs.14/- per bag as per the government standards, the same prices for both NCU and NU are charged by middle men in order to make some profit. On an average, farmers are found to have purchased these fertilizers from the nearby markets (within a radius of 1-3 km). It is apparent that the transport cost is relatively the same (Rs.6.50/- per bag) for both NCU and NU fertilizers.

As regards all the sample States, Punjab paddy farmers tend to buy a slightly higher quantity of NCU (1150kg) fertilizers, followed by Bihar (750kg) and Karnataka (732kg), whereas a higher quantity of NU purchase (711 kg) is noticed in respect of Karnataka followed by Punjab (550 kg) and Madhya Pradesh (210 kg) when, it comes to the purchase of NU. Excepting Madhya Pradesh and Assam, the average quantity of NCU/NU purchased is higher than the aggregate quantity. In these two States, the purchase amounts to less than 215 kg per household. The highest NCU/NU price per bag is found charged in Assam (Rs. 350/ bag each) and the lowest in Punjab (Rs.271/bag of NU and 285/bag of NCU). It is noteworthy that an exact (highest) price difference of Rs. 14 per bag of 50 kg of NCU and NU is observed only in respect of Punjab, whereas, in other States, the price difference amounts to less than the prescribed standards set by the

government. Excepting Karnataka, the average distance from farm-to-market for purchase of fertilizers (NCU/NU) is 1-3 km, while the distance is 7-8 km in the case of Karnataka. Accordingly, the transportation costs are more (Rs. 14 to 17 per bag) in Karnataka. However, the charges vary from four rupees to thirteen rupees per bag in the case of other paddy sample-States. A slightly higher transportation price of NU is due to its stickiness, especially in irrigated regions.

Table 4.2.1.1: Purchase pattern of NCU among paddy-farmers across the selected states

(Per household)

Sl. No.	Particulars	Karnataka		Bihar		Punjab		Madhya Pradesh		Assam		Overall	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU
1.	Quantity bought (Kg)	732	711	750	-	1150	550	200	210	125	95	463	215
2.	Price (Rs per bag of 50kg)	327	320	348	-	285	271	306	298	350	350	323	309
3.	Distance from farm (Km)	7.18	7.86	3	-	2.7	3.0	2.2	2.1	3.2	2	2	2
4.	Transport cost (Rs per bag of 50kg)	14	17	7.5	-	4.7	5.0	11.5	11.1	9.3	13.2	6	7
Total cost (Rs per bag of 50kg)		**342**	**337**	**356**	**-**	**290**	**276**	**318**	**309**	**359**	**363**	**329**	**316**

4.2.1.2. Purchase pattern of NCU and NU fertilizers related to tur-farmers

The details of purchase pattern of NCU and NU among tur-farmers are presented in **Table 4.2.1.2**. The table gives a comparative picture of the usage of NU and NCU fertilizers in respect of Tur crop. Overall, similar to paddy-farmers, tur farmers also tend to purchase a higher quantity of NCU (233 kg/ household) as compared to NU users (187 kg/ household). An average price of NCU amounts to Rs.360/- per bag of 50 kg, which is slightly high as compared to NU (Rs.337/- per 50 kg bag). On an average, farmers purchase these fertilizers from the nearby markets within a radius of 11-13 km. It is apparent that the transport cost is relatively the same (Rs.22/- per bag) for both NCU and NU.

Table 4.2.1.2: Purchase pattern of NCU among Tur-farmers

(Per household)

Sl. No.	Particulars	Karnataka		Bihar		Punjab	
		NCU	NU	NCU	NU	NCU	NU
1.	Quantity bought (Kg)	405	326	62	49	233	187
2.	Price (Rs per bag of 50 kg)	396	374	324	300	360	337
3.	Distance from farm (Km)	13	16	10	10	12	13
4.	Transport cost (Rs per bag of 50 kg)	28	26	18	17	23	22
Total cost (Rs per bag of 50 kg)		**424**	**400**	**342**	**317**	**383**	**359**

Considering both the sample States, Karnataka tur-farmers tend to purchase more than six times higher the quantity of NCU and NU (405 kg and 326 kg) in comparison to Maharashtra (62 kg and 49 kg). A highest price- difference of Rs.24 per bag of 50 kg of NCU and NU is noticed in respect of Maharashtra, whereas, the difference is Rs.22 in Karnataka. The average distance from farm-to-market for purchase of NCU/ NU fertilizers is around 11-13 km, while the distance is slightly higher in the case of Karnataka (13-16 km). Accordingly, the transport costs are comparatively high in Karnataka. Moreover, the transportation cost of NU is a little higher when compared to NCU due to stickiness of NU, especially during Kharif season.

4.2.1.3. Purchasing pattern of NCU and NU fertilizers among sugarcane, maize, soybean and jute farmers

The details of purchase pattern of NCU and NU fertilizers in respect of sugarcane, maize, soybean and jute crops are presented in **Table 4.2.1.3**. By and large, NCU farmers are observed to have purchased a higher quantity of fertilizers as compared to NU users. Among these crops, the fertilizer usage is as high as 770 kg per household of NCU and 616 kg of NU in the case of sugarcane in Maharashtra. Like any other crop, NCU purchase is high as compared to NU. With regard to maize, on an average, Bihar farmers are found to have bought 105 kg of NCU and 135 kg of NU. Interestingly, NU purchase is higher than NCU among maize farmers in Bihar. Soybean farmers in Madhya Pradesh are observed to have purchased about 147 kg of NCU and 96 kg of NU, wherein, the purchase pattern seems to be as usual in respect of other crops. In Assam, jute purchased by farmers amounts to on an average 119 kg of NCU and 21 kg of NU. The purchase of lesser quantity of NU might be due to the non-availability of NU in the State during the reference period. The average price of NCU amounts to as high as Rs.330/- per 50 kg bag in the case of maize farmers in Bihar, followed by Rs. 324 per bag of 50 kg in Assam.

Table 4.2.1.3: Purchase pattern of NCU among sugarcane, maize, soybean and jute farmers

(Per household)

Sl. No.	Particulars	Sugarcane		Maize		Soybean		Jute	
		Maharashtra		Bihar		Madhya Pradesh		Assam	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU
1.	Quantity bought (Kg)	770	616	105	135	147	96	119	21
2.	Price (Rs per bag of 50 kg)	299	285	330	270	305	299	324	350
3.	Distance from farm (Km)	5	6	2	2	7	7	3	2
4.	Transport cost (Rs per bag of 50 kg)	12	13	10	12	9	10	9	13
Total cost (Rs per bag of 50 kg)		**311**	**297**	**337**	**309**	**314**	**309**	**333**	**363**

Unfortunately, NU prices are higher (Rs. 350 per bag of 50 kg) than NCU prices (Rs. 324 per bag of 50 kg) in the case of Assam. The higher prices of NCU/ NU observed in respect of Assam might be due to higher cost of transportation. On the contrary, NCU prices seem to be less (Rs. 299/ 50 kg bag) in Maharashtra, while NU prices are lowest in Bihar (Rs. 270/ 50kg bag). A highest price-difference of Rs. 60 per bag of 50 kg of NCU and NU is observed for Bihar (maize-farmers) followed by Maharashtra (sugarcane-farmers) (Rs.15) and Madhya Pradesh (soybean) (Rs. 6). Relatively the same price-difference is found across crops in different States. The average distance from farm-to-market for purchase of NCU/ NU fertilizers is found 2-7 km across crops and States. Interestingly, the transport cost is comparatively high in the case of NU than NCU in respect of sugarcane, maize and jute crops and vice versa in the case of soybean. As a result, the total costs are higher than the purchase costs in respect of almost all States.

4.2.2: Sources of purchase of NCU and NU fertilizers

4.2.2.1: Sources of purchase of NCU and NU fertilizers in respect of paddy-farmers

The details of sources of purchase of NCU and NU for paddy farmers in the study area are presented in **Figure 4.2.2.1**. It is revealed from the table that, overall, private fertilizer dealers are the major source of purchase of NCU, while cooperative societies are major source in the case of NU (57% each) and the situation is vice-versa in respect of the second important source of purchase (41% each). However the contribution of Raitha Samparka Kendras (RSKs) and State Department of Agriculture appears to be insignificant.

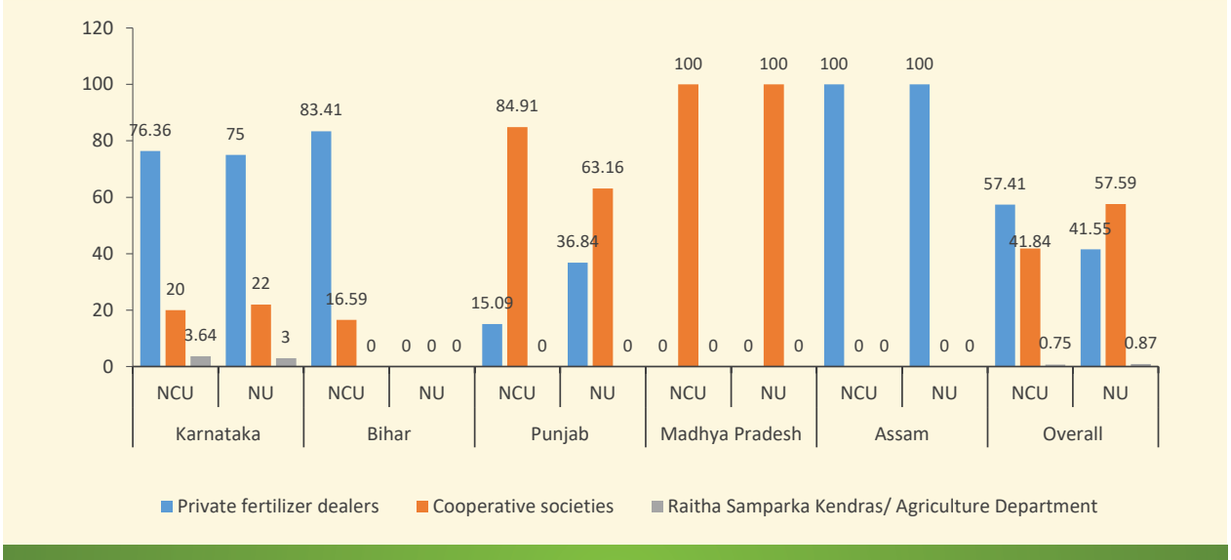


Figure 4.2.2.1: Sources of purchase of NCU and NU fertilizers in respect of paddy-farmers

As regards all the paddy sample States, again private fertilizer dealers are the major source of purchase for both NCU and NU in Assam (100% each) as well as Karnataka (>75%). However,

about 15 per cent of the farmers in Punjab are found to have purchased NCU from private fertilizers, while this proportion is 37% with respect to NU. The Cooperative Societies are the major source of purchase in Madhya Pradesh (100% each), whereas, it is 85 per cent in the case of NCU and 63 per cent with regard to NU in Punjab. About 20 per cent of the farmers also are observed to have preferred cooperative societies for purchase of NCU and 22 per cent for NU in Karnataka. About 17 per cent of the farmers from Bihar have reported that they had purchased NCU from Cooperative Societies. Only in the case of Karnataka, a negligible proportion (4%) of the farmers is found to have purchased NCU & NU from State Department of Agriculture/ RSKs.

4.2.2.2: Sources of purchase of NCU and NU fertilizers in respect of tur/ redgram-farmers

The details of sources of purchase of NCU and NU with regard to Tur-farmers in the study area are presented in **Figure 4.2.2.2**. It is revealed from the table that, overall, private fertilizer dealers are the major source of purchase both in the case of NCU (100%) and NU (97%). Similar is the condition across both the States, Karnataka and Maharashtra for both NCU and NU. Cent per cent of Maharashtra farmers are found to have purchased both NCU and NU from private fertilizer dealers. Only in Karnataka, about seven per cent of the farmers have reported purchasing NU from Cooperative Societies, while this proportion is negligible (4%) in the case of NCU.

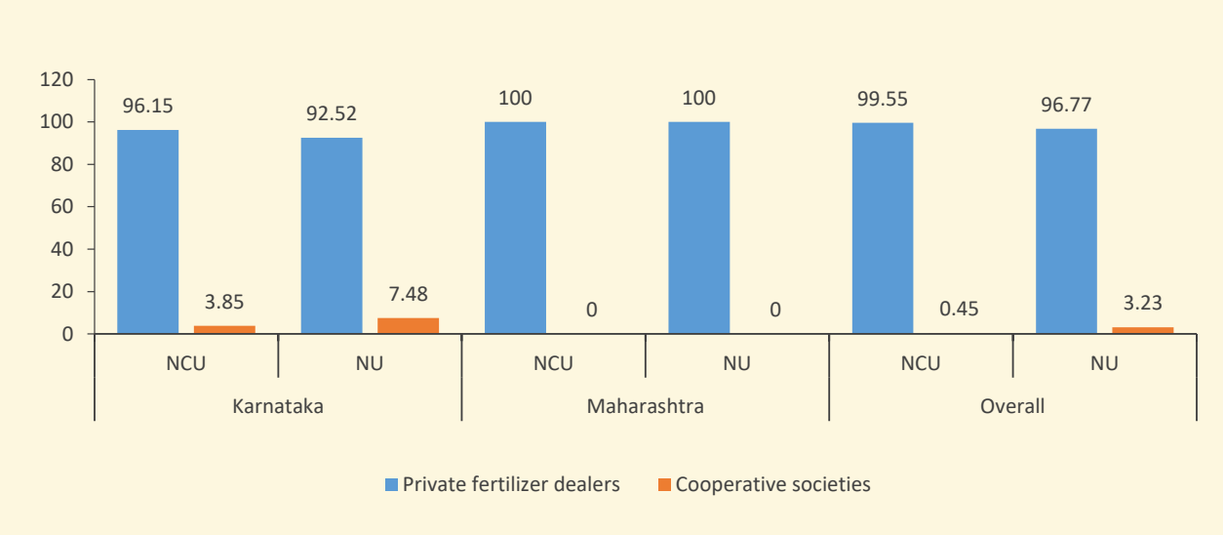


Figure 4.2.2.2: Sources of purchase of NCU and NU fertilizers in respect of tur/ redgram-farmers

4.2.2.3: Sources of NCU and NU fertilizers purchase for sugarcane, maize, soybean and jute farmers

The details of sources of purchase of NCU and NU for sugarcane, maize, soybean, and jute farmers are presented in Figure 4.2.2.3. It can be observed from the table that like paddy and tur crops, private fertilizer dealers are the major source of purchase of NCU and NU for the

farmers of sugarcane, maize, soybean and jute crops in Maharashtra, Bihar, Madhya Pradesh and Assam respectively.

In the case of sugarcane in Maharashtra, private fertilizer dealers are the major source of purchase of NCU and NU, according to 75 per cent and 60 per cent of the respective farmers, and for the rest of the farmers' cooperative societies are the major source. Correspondingly, maize farmers from Bihar are observed to have purchased both NCU and NU from private fertilizer dealers (86% and 91% respectively) and the remaining from cooperative societies. Similarly, in the case of Assam, private fertilizer dealers are the only source for almost all the farmers for purchase of both NCU and NU fertilizers. On the contrary, a majority of the farmers have reported (>73%) cooperative societies as the prime source for purchase of NCU and NU fertilizers, while the remaining 23 to 27 per cent have reported private fertilizer dealers as main source.

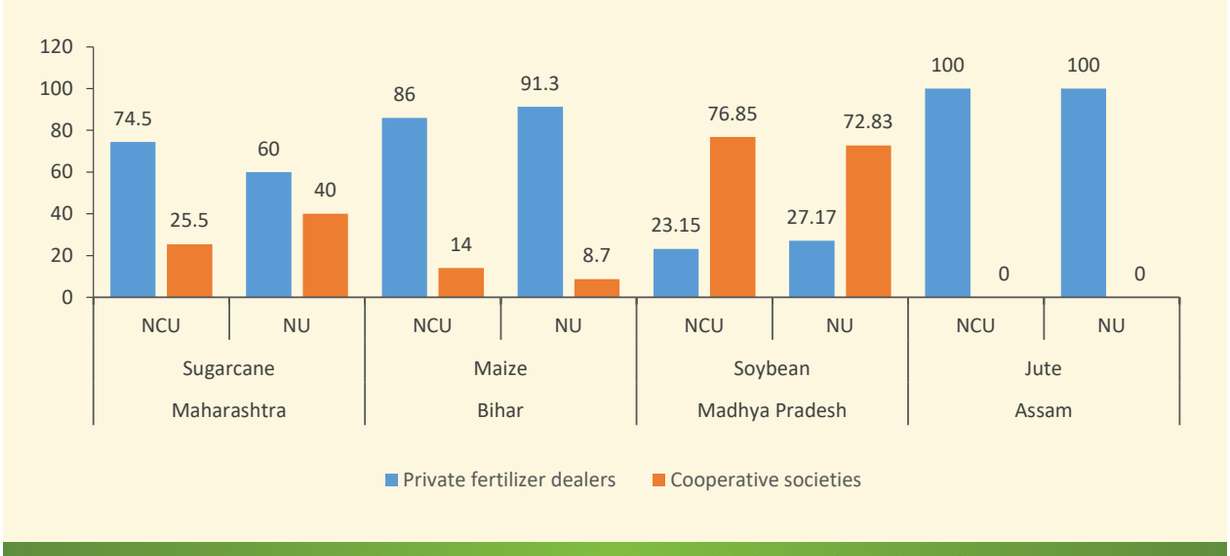


Figure 4.2.2.3: Sources of purchase of NCU and NU fertilizers in respect of sugarcane, maize, soybean and jute farmers

4.3. Status of Application of NU relative to NCU

4.3.1. Application of NCU across different seasons by respondents

The details of application of NCU across different seasons by the sample respondents are shown in **Table 4.3.1**. It is clear from the table that, excepting tur crop, more than 49 per cent of sample farmers have applied NCU to the reference crops after 2015-16 during Kharif. This might be due to Govt. of India making mandatory the production of NCU across the country. However, about 31 per cent of the farmers in the case of paddy, 27 per cent of maize farmers and six per cent of tur farmers also used to apply NCU before 2015-16, mainly because the production of NCU was up to 35 per cent of the total production in the country. In the rabi season, a greater

proportion of wheat farmers (96%) is found to have applied NCU during 2015 as compared to 2014 (20%). In respect of other crops such as potato and vegetables, there seems to be a slight increase in the usage of NCU as compared to earlier.

Table 4.3.1: Application of NCU across different seasons by respondents

(% of farmers)

Sl. No.	Name of the crops	Before 2015-16	After 2015-16
Kharif season			
1.	Paddy	31.3	81.50
2.	Tur	6.25	27.50
3.	Sugarcane	-	68.00
4.	Maize	26.50	74.00
5.	Soybean	-	54.00
6.	Jute	-	49.00
Rabi season			
7.	Potato	3.00	6.50
8.	Wheat	20.00	96.00
9.	Vegetables	1.75	4.75

4.3.2. Split doses of NCU / Normal Urea application by respondents

4.3.2.1. Split doses of NCU / Normal Urea application by paddy, tur and jute farmers

The details of split doses of NCU and NU application with respect to paddy, tur and jute crops are shown in **Figure 4.3.2.1**. It is observed across the sample crops that, the proportion of fertilizers applied in different stages of the crop growth varies across crops. In the case of paddy, almost the same proportion (38%) of fertilizers is found to have been applied during the vegetative stages of crop growth. Although there is a decrease observed in the proportion of NCU (33%) fertilizers applied after weeding as compared to NU fertilizers (39%), the proportion shows an increase at the time of basal application (20%) in place of 12 per cent of NU. More or less the proportion remains at the time of maturity.

The share of urea application (NU/NCU) is found highest in the case of tur crop at the time of basal application, followed by maturity stage, after weeding and vegetative growth. However, this proportion is observed to have varied post the introduction of NCU, from 61 per cent of NU (Kharif 2014) to 47 per cent of NCU at the time of basal application during Kharif 2015, While the proportion of NCU application has increased after weeding and maturity stages from 13 per cent to 10 per cent and 15 per cent to 30 per cent, respectively. A very small quantity of NCU is found applied during the vegetative growth stage.

With regard to jute crop, a higher proportion (51%) of NCU is found applied during vegetative growth as against post weeding in the case of NU (48%). The basal application shows an increase from seven per cent (Kharif 2014) to 30 per cent during Kharif 2015. However, no NCU is found applied at the time of maturity during Kharif 2015, though, NU had been applied to the extent of about three per cent during Kharif 2014.

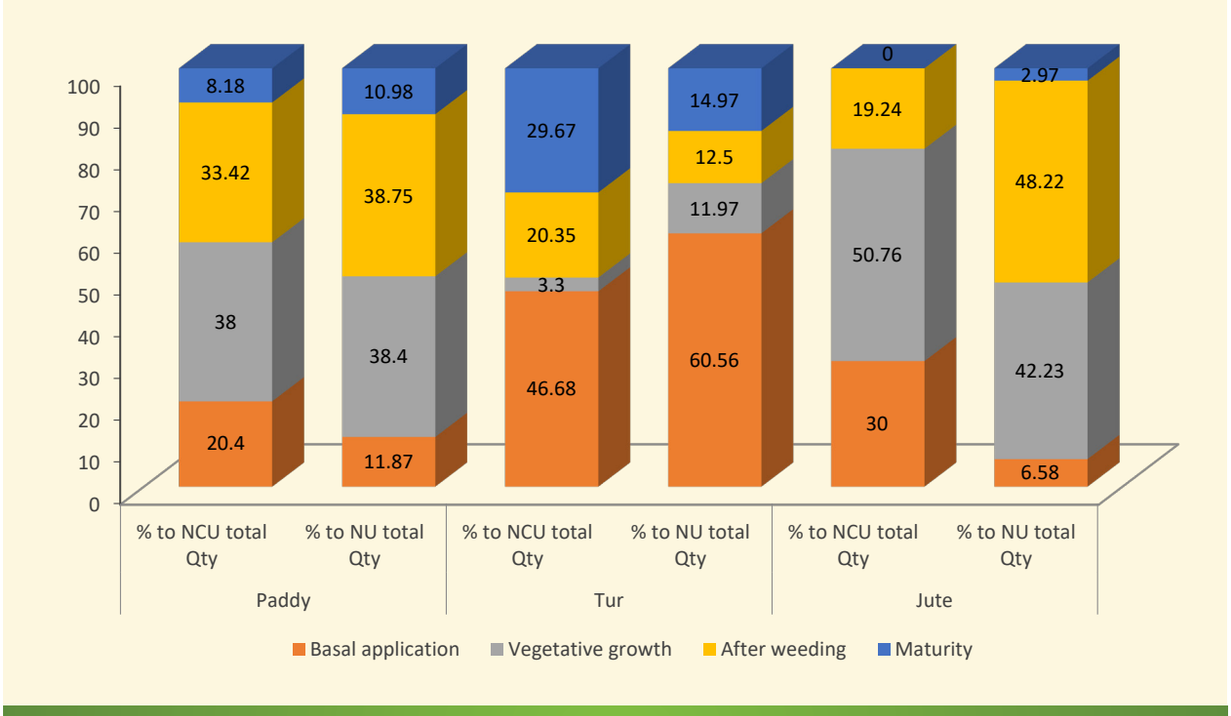


Figure 4.2.3.1: Split doses of NCU / Normal Urea application by the sample farmers of paddy, tur and jute (kg/acre)

4.3.2.2. Split doses of NCU / Normal Urea application by sugarcane, maize and soybean Farmers

The details of split doses of NCU and NU application with reference to sugarcane, maize and soybean are shown in **Figure 4.3.2.2**. Across the reference crops a relatively the same quantity of NCU/ NU found applied during the different stages of crop growth in the case of sugarcane and soybean. However, there is no NCU/ NU observed applied post the vegetative growth in respect of soybean, whereas, both NCU and NU are found to have been applied during all the stages of crop growth in the case of sugarcane. With regard to maize-crop, more than half (53%) of NCU is found applied at the time of vegetative growth only, and the rest (47%) post weeding. Whereas, during Kharif 2014 (when NU is applied), the total quantity had been applied during the three stages, with a highest of 41 per cent at the time of basal application followed by vegetative growth (30%) and after weeding (29%).

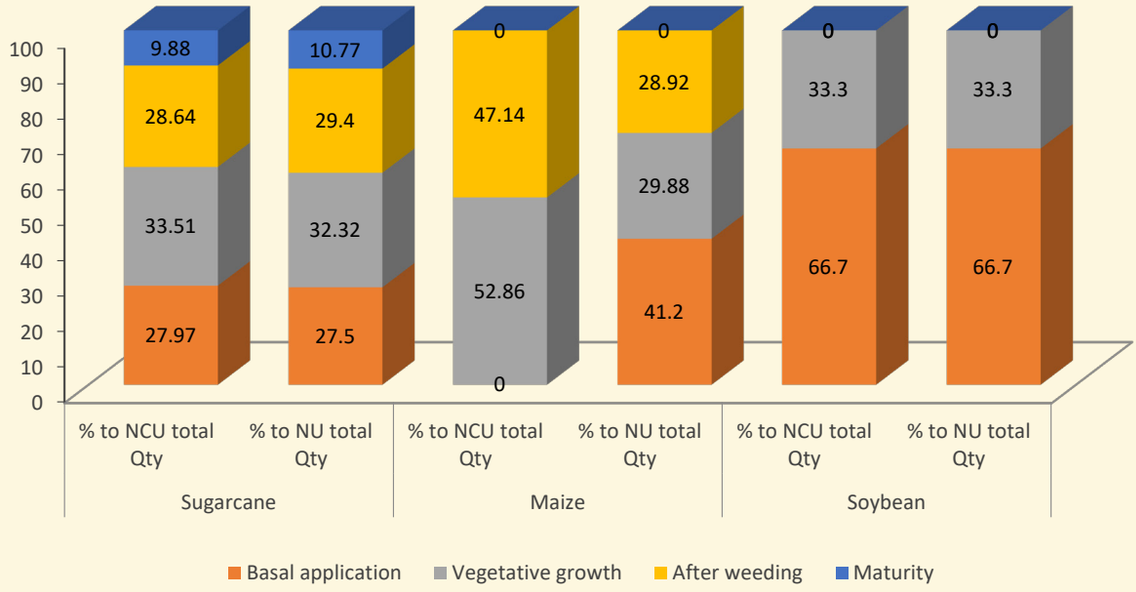


Figure 4.2.3.2: Split doses of NCU / Normal Urea application by the sample farmers of sugarcane, maize and soybean (kg/acre)

4.4. Perceptions of farmers regarding NCU and its benefits as compared to NU

Table 4.4 depicts the perceptions of farmers regarding NCU use in relation to NU across all the reference crops selected for the study. With regard to NCU quality, a majority of the farmers have opined that the quality is good for almost all the crops such as paddy (56%), sugarcane (85%), maize (78%), soybean (65%) and jute (44%). However, according to a majority of the (60%) tur-farmers there is no change in terms of its quality as compared to NU, but as per about 15 per cent to 38 per cent of tur-farmers the NCU quality is very good. Excepting a majority of the tur-farmers (61%), more than half of the respondents in the case of each crop have expressed that the NCU availability is adequate as compared to NU. However, 40 per cent of paddy, eleven per cent of maize and 18 per cent of jute farmers have expressed that, there is no change in terms of its availability in comparison to NU period.

As an exception to tur farmers, undoubtedly, more than 72 per cent of farmers in the case of each reference crop have reported that timely availability of NCU for Kharif 2015. In the case of tur as per the majority of the farmers (69%) there is no timely availability of NCU. According to more than half of the sample farmers in the case of all reference crops the price of NCU is reasonable, not very high, while as per about 30 per cent, 62 per cent, 28 per cent and 18 per cent of paddy, tur, soybean and jute farmers respectively, there is no change in NCU price, rather it is the same as urea. This is mainly because sellers/ input dealers sell both NCU and NU

at the same price in order to make some profit, even as there is a slight increase observed in NCU prices due to the additional cost of neem coating.

Table 4.4: Perceptions regarding NCU in relation to NU

(% of farmers)

Sl. No.	Particulars	Paddy	Tur	Sugarcane	Maize	Soybean	Jute
1	**Neem Coated Urea quality**						
	Very good	17.30	2.84	14.70	17.00	35.19	38.00
	Good	56.00	36.11	85.30	77.50	64.81	44.00
	Bad	8.50	1.05	-	5.50	-	-
	No change	18.20	60.00	-	-	-	18.00
2	**Neem Coated Urea availability**						
	Adequate	51.30	31.70	83.10	81.50	96.30	82.00
	Inadequate	8.50	7.04	16.90	8.00	3.70	-
	No change	40.20	61.26	-	10.50	-	18.00
3	**Timely availability of Neem Coated Urea**						
	Yes	71.50	30.87	80.00	83.50	87.04	82.00
	No	28.50	69.13	20.00	16.50	12.96	18.00
4	**Neem Coated Urea Price**						
	Very high	0.20	3.53	1.50	-	14.81	-
	High	38.80	17.25	44.90	35.00	15.74	29.50
	Not very high	29.40	16.90	50.70	65.00	41.67	52.50
	Same as urea	31.60	62.32	2.90	-	27.78	18.00
5	**Benefits of NCU in terms of total fertilizer usage**						
	Increased	13.40	29.22	91.90	---	34.26	50.50
	Decreased	21.80	11.63	1.50	67.50	16.67	31.50
	No Change	64.80	59.15	6.60	32.50	49.07	18.00
6	**Benefits of NCU in terms of Urea usage**						
	Increased	16.30	27.46	91.10	---	10.19	50.50
	Decreased	15.90	21.14	5.20	53.50	12.96	31.50
	No Change	67.80	51.40	3.70	46.50	76.85	18.00
7	**Pest and disease attack**						
	Increased	0.80	11.26	3.70	0.50	-	-
	Decreased	46.10	21.14	40.40	85.00	4.63	73.00
	No Change	53.37	67.60	55.90	14.50	95.37	27.00
8	**NCU is more easily accessible in the market as compared to normal Urea**						
	Yes	53.70	5.63	25.70	71.50	35.20	82.00
	No	46.30	94.37	74.30	28.50	64.81	18.00

Benefits of NCU in terms of the total fertilizer usage and urea usage, majority of the (92%) sugarcane-farmers and half of the jute farmers believe that, the use of the both has increased. On the contrary, a majority of the paddy, tur, maize, and soybean farmers have experienced no change in the total fertilizer usage and urea usage. Interestingly, about 68 per cent and 54 per cent of maize farmers and 32 per cent each of jute farmers have noticed a decrease in both the

total fertilizer and urea usage, respectively. On the other side according to more than 50 per cent of paddy, tur, sugarcane, and soybean farmers, there is no change in the pest and disease attacks. On the contrary, as per 46 per cent of paddy, 40 per cent of sugarcane, 85 per cent of maize, and 73 per cent of jute farmers, there has been a decrease in pest and disease attacks post NCU usage. Similarly, paddy, maize and jute farmers have expressed that NCU is more easily accessible in the market as compared to NU, but tur, sugarcane and soybean farmers have rejected this statement.

Overall, we can conclude that for a majority of the farmers across the sample States the quality, adequacy and timely availability of NCU is good and has improved further post the mandatory production and distribution of NCU, as compared to NU, while, the prices have increased slightly. Further, the usage of total fertilizers and urea fertilizers is more or less the same. The incidence of pest and disease attack also has decreased. The accessibility of NCU has improved post mandatory production as compared to NU in the selected States. However, a handful of farmers also have experienced a decrease in cost of pest and disease control, a reduction in the application of total fertilizers and urea applied post the introduction of NCU in the market.

4.5. Usage of inputs and profitability from reference crops

4.5.1. Input use, output and returns realized by paddy farmers

The details of input use, output and returns realized by farmers per acre of paddy are presented in **Table 4.5.1**. A perusal of the table reveals that, overall, the total paid-out costs show a slight increase (Rs.407/- per acre) for Kharif 2015 as compared to Kharif 2014. This increase in cost spreads across different input costs incurred in the production process of paddy. Although the prices of NCU are found to be slightly higher than for NU, the total cost incurred shows a NU/NCU drastic reduction for Kharif 2015. Similar is the case with the cost on other fertilizers. However, both the main product and by-products have increased to an extent of three quintals per acre. Accordingly, on an average, the net returns shows increase to an extent of Rs.4100/- per acre during for 2015 as compared to Kharif 2014.

Overall in the case of paddy, the paid out costs shows an increase in respect of almost all the sample States. Interestingly, the cost of NU/NCU shows a slight reduction in the case of Punjab and Assam paddy producers for Kharif 2015 as compared to Kharif 2014. In addition, the cost on other fertilizers and PPCs also shows a slight reduction in Assam. While the cost on other chemical fertilizers is found to have increased, the cost on PPCs has declined with respect to Karnataka farmers. It is worth mentioning that the main product output has increased in almost all the paddy sample states in the country. Excepting Bihar, the by-product quantity also has increased in all other States. Accordingly, the net returns have increased in all the paddy sample States.

Table 4.5.1: Input use, output and returns realized by paddy-farmers across sample states

(Kg/Acre)

Sl. No.	Particulars	Karnataka		Punjab		Madhya Pradesh		Bihar		Assam		Overall	
		2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014
Input use and their costs													
1	Ploughing and sowing charges (only machinery)	3731	3290	2340	2215	1387	1260	3071	2974	2534	2365	1992	1844
2	Seed cost/ purchase of seedlings	865	815	284	266	950	897	1597	1498	691	583	714	660
3	Organic/FYM	929	740	76	64	391	381	---	---	205	194	737	658
4	Urea/NCU	713	622	741	758	322	269	584	557	360	489	317	336
5	Chemical fertilizers (Other than Urea/NCU)	6797	6538	642	584	1187	1126	654	568	986	1073	1962	2005
6	Plant protection chemicals	4717	4742	1918	1897	686	643	752	656	223	231	1450	1482
7	Irrigation charges	172	120	457	690	108	125	412	315	650	579	211	208
8	Harvesting & threshing charges	3461	3315	1026	977	1950	1729	2027	1876	1697	1502	1353	1301
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	2970	2804	2385	2224	1572	1441	1201	1260	1964	1788	3302	3323
10	Imputed value of family labour	1760	1549	74	78	654	600	137	158	1974	1879	900	874
11	Hired labour (amount paid)	2388	2197	291	275	1130	996	1475	1150	1405	1323	1316	1207
12	Maintenance costs on assets used for the reference crop	1210	998	198	181	280	29	99	73	92	86	380	329
13	Total paid-out costs including imputed value of own labour	29712	27729	10432	10209	10024	9013	12009	11086	12781	12090	14634	14227
Returns													
1	Output (Main product in quintal)	36	28	29	28	19	15	29	27	16	14	26	23
2	By product	67	62	0	0	33	25	31	38	32	28	41	38
3	Gross returns	51186	41233	41833	39740	21855	17914	29740	28042	18759	17186	38250	33744
4	Net returns	21474	13492	31401	29530	11237	8420	17730	16956	5978	5095	23616	19517

4.5.2. Input use, output and returns realized by tur-farmers

Table 4.5.2 represents the details of input use, output and returns realized by per acre by tur-farmers in Karnataka and Maharashtra states. Overall, the total paid-out costs incurred by tur-farmers works out to Rs.12695/- per acre for Kharif 2015 as against Rs.12149/- per acre for Kharif 2014. The small increase in the paid-out cost is distributed across other variables used in the production of tur excepting in organic fertilizers/ FYM, harvesting and threshing charges and imputed value of family labour. Notably, the tur production has increased by 0.95 quintals per acre during Kharif 2015 as compared to 2014, while the by-product has decreased from 2.30 quintals per acre in 2014 to 1.90 quintals in 2015. On the contrary, the net returns have decreased which could be due to a fall in the prices of Tur.

Table 4.5.2: Average input use, output and returns realized by tur-farmers with respect to Karnataka and Maharashtra

(Kg/Acre)

Sl. No.	Particulars	Karnataka		Maharashtra		Overall	
		2015	2014	2015	2014	2015	2014
Input use and their costs							
1	Ploughing and sowing charges (only machinery)	2151	2034	2018	1761	2040	1923
2	Seed cost/ purchase of seedlings	417	346	717	596	451	380
3	Organic/FYM	1153	1159	490	369	1964	2054
4	Urea/NCU	268	226	268	270	268	248
5	Chemical fertilizers (Other than Urea/NCU)	1340	1332	1222	1050	1281	1191
6	Plant protection chemicals	1610	1751	958	847	1171	1202
7	Irrigation charges	16	16	201	167	223	198
8	Harvesting & threshing charges	1640	1721	1579	1593	1649	1702
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	710	704	810	737	733	724
10	Imputed value of family labour	1108	1180	1094	1001	947	1025
11	Hired labour (amount paid)	852	939	1003	963	1598	1027
12	Maintenance costs on assets used for the reference crop	230	191	335	283	370	475
13	**Total paid-out costs including imputed value of own labour**	**10902**	**10977**	**10692**	**9638**	**12695**	**12149**
Returns							
1	Output (Main product in quintal)	2	3	4.03	4.28	3.60	2.65
2	By product	2	3	1.75	1.72	1.90	2.30
3	Gross returns	17027	19182	37272	23503	18850	19065
4	Net returns	6285	8206	26580	13865	6155	6916

Across states, the paid-out costs of tur are found relatively same in respect of Karnataka, whereas in Maharashtra, the paid-out costs show an increase from Rs.9638/- per acre to Rs. 10692/- for 2015. The slight increase observed in the costs is mainly due to an increase in ploughing and sowing charges and costs on chemical fertilizers (other than NU/NCU), whereas, in other cases, the costs are found almost the same between 2015 and 2014. Remarkably, there is a decrease observed in output both in terms of main product and by-product of tur in both the states, due to successive drought conditions in the sample area. However, tur output is found to be better in Maharashtra during both the seasons (Kharif 2014 & 2015) depending upon the severity of drought in these states. Further, a better price is observed for tur in Maharashtra during Kharif 2015, and accordingly they could get better net returns (more than four times) as compared to farmers in Karnataka, where, they are found to have incurred a loss of Rs.1972/- per acre for Kharif 2015 as compared to 2014.

4.5.3. Input use, output and returns realized by sugarcane, maize, soybean and jute farmers

The details of input use, output and returns per acre of sugarcane, maize, soybean and jute crops are presented in **Table 4.5.3**. It is revealed from the table that, the total paid-out cost incurred on sugarcane crop in Maharashtra is highest (Rs.36384/- per acre) for Kharif 2015, as against Rs.33193/- for Kharif 2014, with the increase in cost distributed across all inputs used in the production processes. Interestingly, there is a slight reduction observed in the cost of NCU as compared to NU. Although the costs have increased during Kharif 2015, the output shows an increase both in terms of the main product (about four quintals/ acre) and by-product (0.36 tonnes/acre) as compared to Kharif 2014. Accordingly the increase in net returns amounts to Rs. 11968/- per acre for Kharif 2015 as against Kharif 2014.

Similarly, in the case of Madhya Pradesh, the paid-out costs incurred per acre on soybean crop is highest (Rs.9776/-) for Kharif 2015 as against Rs. 8660/- in 2014. There is a minor increase observed in the cost of NCU as compared to NU for Kharif 2015 and a slight decrease in the cost of other chemical fertilizers post adoption of NCU, with the rest of the increased cost distributed across different inputs during Kharif 2015. Consequently, the production of both the main output and by-products have increased in Kharif 2015. The increase in output and by-products may not be directly attributed to the use of NCU alone. However, the increase in net returns works out to Rs. 1401/- per acre for Kharif 2015 as against Kharif 2014.

With respect to maize crop in Bihar, the paid-out costs have shown an increasing trend for Kharif 2015 as compared to Kharif 2014, with the increased costs (though not substantial) (Rs.891/- per acre), distributed across different inputs. There is an increase of one quintal in the case of main product and a decrease of six quintal in the case of by-product, post adoption of NCU in place of NU. Accordingly, there is an increase in the net returns to an extent of Rs.3301/- per acre.

With reference to jute in Assam, the paid-out costs along with other inputs are found relatively same for Kharif 2015 and Kharif 2014. In fact, there is a decrease in the main product to an extent of one quintal per acre during Kharif 2015 as compared to Kharif 2014, however, the quantity of by-product has remained same in both the seasons. As a result, there is a decrease in the net returns to the extent of Rs. 883/- per acre for Kharif 2015 as against Kharif 2014.

Table 4.5.3: Input use, output and returns realized by sugarcane, maize, soybean and jute farmers

Sl. No.	Particulars	Maharashtra		Madhya Pradesh		Bihar		Assam	
		Sugarcane		Soybean		Maize		Jute	
		2015	2014	2015	2014	2015	2014	2015	2014
Input use and their costs									
1	Ploughing and sowing charges (only machinery)	4200	3860	601	516	1179	1111	1146	1131
2	Seed cost/ purchase of seedlings	5576	5107	2199	1860	3600	3772	268	234
3	Organic/FYM	2665	2220	174	165	---	---	527	704
4	Urea/NCU	1602	1720	114	87	1131	1291	249	304
5	Chemical fertilizers (Other than Urea/NCU)	5833	4841	1206	1233	953	1217	681	553
6	Plant protection chemicals	1374	1031	667	619	486	450	126	137
7	Irrigation charges	2469	2270	11	2	849	860	0	0
8	Harvesting & threshing charges	0	0	832	709	1947	2218	7000	7000
9	Hired labour charges (including ploughing charges till planting, cost or sowing/ transplanting)	3702	3453	341	309	332	307	363	363
10	Imputed value of family labour	4540	4329	1334	1289	349	390	1790	1865
11	Hired labour (amount paid)	2442	2528	1995	1735	1203	1323	1816	1741
12	Maintenance costs on assets used for the reference crops	1981	1832	301	138	281	265	44	46
13	**Total paid-out costs including imputed value of own labour**	**36384**	**33193**	**9776**	**8660**	**12312**	**13203**	**15349**	**15353**
Returns									
1	Output (Main product in quintal)	53.29	49.30	10.16	8.98	24	23	6	7
2	By product (tonnes)	0.83	0.47	14.33	10.20	29	35	8	8
3	Gross returns	117506	102337	17788	15271	29421	27012	18820	19398
4	Net returns	81122	69144	8012	6611	17110	13809	3082	3965

4.6. Diversion of NU and NCU towards other than crop purposes

All the sample farmers from the study were asked about the usage of NCU for other than crop production purposes. It has been found during the survey that, a very few farmers have used NU in cattle and fishery feed preparation, mixing with milk to enhance the fat content etc., with a very minute quantity (0.1gm/ kg). However, post introduction of NCU, none of the sample farmers is found to have used has NCU for any purpose other than crop production purposes.

4.7. Constraints and suggestions regarding NCU and its adoption

4.7.1. Major problems faced in the adoption of NCU fertilizer

The problems appear to be relatively the same, irrespective of the reference crops. The major problems faced in the adoption of NCU fertilizers in place of NU are listed in **Table 4.7.1**. It can be observed from the table that, the problems vary across States though not substantially. With regard to farmers in Punjab and Karnataka, a higher price of NCU is the chief problem, as reported by 95 per cent and 46 per cent of the farmers respectively, while lack of awareness regarding the benefits of NCU use is the main problem as expressed by 100 per cent of soybean farmers in Madhya Pradesh, and more than one-fourth of the farmers in Assam and Karnataka. In addition, 'no trainings' on crop-wise application of NCU is the other important problem, as perceived by half of the soybean farmers in Madhya Pradesh and 44 per cent of the maize-farmers in Bihar. 'Lack of information' on NCU and lack of rainfall/ irrigation facilities in the Kharif season 2015, are the reasons cited by 40 per cent each of the farmers from Karnataka and Bihar, respectively. The other problems reported by the overall farmers include foul smell of NCU, shortage/ inadequate supply of NCU, distant locations for purchase of NCU fertilizers etc.

4.7.2. Major suggestions for improving NCU fertilizer usage

Major suggestions towards the improvement of NCU fertilizer usage made by sample farmers are illustrated in **Table 4.7.2**. It can be seen from the table that a greater proportion of soybean (72%), maize (61%) and paddy farmers (35%) have suggested the organizing of training programmes on NCU fertilizer application for farmers across the States. The second important suggestion made by soybean (68%), jute (57%), paddy (44%), maize (31%) and tur (25%) farmers relates to the spreading of awareness regarding NCU usages and its benefits vis-à-vis. The other suggestions offered by the overall farmers include a reduction in NCU prices, supply of NCU before the sowing season, ensuring the availability of fertilizers at the village/ Panchayat level, conducting of demonstrations on NCU application etc. Interestingly, about 65 per cent each of tur and sugarcane farmers are satisfied with NCU fertilizers and hence no suggestion offered by them.

Table 4.7.1: Major problems faced in the adoption of NCU fertilizers

(% of farmers)

Sl. No.	Problems	Bihar	Karnataka	Maharashtra	Madhya Pradesh	Punjab	Assam
1	No training on crop-wise application of NCU	43.50	03.63	-	51.00	5.00	-
2	Lack of awareness regarding the benefits of NCU	22.25	25.62	5.30	100.00	5.50	38.66
3	Due to lack of irrigational facilities, the desired benefits of NCU are not extracted/taken	39.25	02.17	-	-	-	-
4	Price of NCU is higher than plain Urea	07.00	46.36	01.80	19.00	94.71	-
5	Distant locations for purchase of fertilizers	26.00	04.54	00.50	11.00	-	-
6	Afraid of duplicate urea in the market	05.25	-	-	-	-	-
7	Lack of fertilizer & water testing laboratories	10.50	-	-	-	-	-
8	Difficult to differentiate between NCU & NU	06.25	01.08	-	-	-	-
9	Bad smell of NCU	-	01.08	-	-	-	-
10	Lack of information on NCU	-	39.09	-	-	-	61.34
11	Shortage of NCU/ Inadequate supply	9.50	-	38.80	40.00	27.00	-
12	Selling of NCU with other fertilizers by the dealers	-	-	00.50	40.00	-	-
13	Lack of capital	-	-	-	16.00	-	-
14	Poor quality	-	-	-	-	8.50	-
15	No issues with NCU	-	-	53.30	-	01.50	-

Table 4.7.2: Major suggestions towards improving NCU fertilizer usage

(% of farmers)

Sl. No.	Suggestions	Paddy	Tur	Sugarcane	Maize	Soybean	Jute
1.	Need to create awareness regarding NCU use	43.55	25.46	5.00	30.50	68.00	56.97
2.	Increase the subsidy amount	1.59	5.35	-	-	-	-
3.	Supply NCU before the sowing season	16.86	22.64	22.00	23.00	-	7.27
4.	Reduce NUC price	22.40	6.10	7.00	-	-	35.76
5.	Provide trainings on fertilizer application	34.90	9.90	0.50	60.50	72.00	-
6.	Need to improve the quality of NCU	1.90	-	-	-	-	-
7.	Ensure the availability of fertilizers at the village/ Panchayat level	9.76	-	-	37.00	-	-
8.	Demonstrations to be conducted on the use of NCU	3.60	-	-	6.00	-	-
9.	Sell NCU through producer companies	9.20	-	-	-	38.00	-
10	No suggestion/ Satisfied with NCU	-	64.50	65.50	-	-	-

4.8. Summary of the chapter

Excepting Karnataka and Maharashtra, most of the sample farmers are aware of NCU use in the study area; and their main sources of information include agricultural officers from the State Department of Agriculture followed by input suppliers/ cooperatives. A majority of the farmers engaged in the production of reference crops, have no difficulty in differentiating between NCU and NU, based on the leaf figure on the bag and colour. With respect to the application of fertilizers, only a negligible proportion of farmers has undergone training programmes at the Department of Agriculture/ Horticulture in the sample states. A majority farmers purchased NCU or NU through private fertilizer dealers. However, it is noticed that these farmers have applied higher quantity of NCU in place of NU may be due to their ignorance about the slow releasing property of NCU and its benefits. Since, NCU was available in the market before Kharif 2015, few farmers across the country used to apply NCU, however, its usage has increased only after Kharif 2015, due to 100 per cent production of NCU because of the government policy decision. It is interesting to note that the usage of total fertilizers and NU/NCU fertilizers are more or less same. On the other side, the incidence of pest and disease attack is on the decline. Overall, the total paid-out costs have slightly increased after NCU (Kharif 2015) as compared to before NCU (Kharif 2014), with the cost increase spread across different inputs used in the production process of the reference crops. Although the prices of NCU are slightly higher than NU, the total cost on NU/NCU shows drastic reduction for Kharif 2015. However, both the main product and by-products have increased, leading to an increase in the net returns during Kharif 2015. Lack of awareness regarding the benefits of NCU and higher prices of NCU are the major problems being faced by a majority of the farmers. Hence, as they have suggested, there is need for creating awareness among farming community regarding the NCU benefits and reducing its price by the government.

Awareness campaign on Soil Health Card and Neem Coated Urea in Bihar

5. Status of Soil Health Card Scheme Implementation and Adoption of Soil Testing Technology by the Farmers

A proper nutrition supply is essential for a satisfactory crop growth and production. Soil analysis is a valuable tool for farm practice, as it determines inputs required for an efficient and economic production. The success of soil analysis depends on how scientifically soil samples are drawn because, the results are only as good as the samples you choose. A proper soil test helps ensure the application of fertilizers on scientific basis as part of meeting the crop requirements, in addition to taking advantage of the nutrients already present in the soil systems. It is observed from various studies carried out across the country that an indiscriminate or sub-optimal use of chemical fertilizers by farmers with a view to increasing crop yield is a common phenomenon which, in turn, has led to a deterioration in the micro-biotic structure of soil systems, wastage of nutrients, destruction of soil stabilizing micro-organisms, and scorching of plants in the extreme cases.

In this regard, both the Union and State Governments have undertaken various initiatives as part of ameliorating the situation and encouraging farmers towards a balanced use of fertilizers. One such important initiative undertaken by the Union Government under National Mission for Sustainable Agriculture (NMSA) during the 12th Plan, was the Soil Health Management (SHM) aimed at promoting Integrated Nutrient Management (INM) through a judicious use of chemical fertilizers based on soil testing technology. This scheme, named as 'Soil Health Card Scheme' (SHC Scheme) was to be effective from 19th February 2015. Realizing the importance of soil health and its management, various states have implemented this programme along with their existing schemes on soil testing in their States. The main objective of these programmes is to issue Soil Health Cards (SHCs) to all farmers within three years. Under this mission, many Soil Health Centres (SHCs), Fertilizer Control Laboratories, and Micro Nutrient Laboratory are established, with the soil samples being analyzed for pH, EC; major nutrients like N, P, K; secondary nutrients like Sulphur and magnesium; and micro nutrients such as Zn, Fe, Mn, Cu and Boron. A field-specific detailed report of soil health and fertility status and other important soil parameters that affect crop productivity is given in the form of a card called SHC. These soil health cards provide an advisory on a soil-test-based use of fertilizers and amendments.

In this report, an effort is made to understand farmers' awareness level regarding soil test technology, adoption level, and issues related to soil test technology in general, and in particular, Soil Health Card Scheme introduced by the Central Government for farmers across the sample

States. The results of the details collected are discussed in this chapter under the following subheadings:

5.1. Status and details of soil testing
5.2. Awareness and sources of information related to soil testing
5.3. Reasons for soil testing or not testing
5.4. Adoption of recommended doses of fertilizer (RDFs) application based on soil test report
5.5. Problems faced in soil testing and suggestions for improvement in Soil Health Card scheme

5.1. Status and details of SHC Scheme

5.1.1. Status of SHC Scheme in sample States and all India

The increased degradation of cultivable land due to intensive cultivation and injudicious use of chemical fertilizers leading to several problems affecting soil health, nutrient flow and natural environment. The situation is more worsening in the recent days as farmers hardly apply lesser quantities of organic manures to the soil. The high intensity of crop production creating nutrient deficiencies and hence regular replacement of depleted nutrients become necessary. But due to the lack of awareness and education among the farming community on the use of chemical fertilizers and their application, there is imprecise use of resources on the one hand, and increased cost of production and environmental degradation on the other hand. Several government schemes and policies have tried to focus on these issues from the last two decades through encouraging farmers to apply balanced use of fertilizers by regular soil testing and adoption of recommended doses of fertilizers to increase productivity of crops and better absorption of nutrients from the applied fertilizers but the results were not satisfactory. In continuation of these efforts, Government of India has launched a Soil Health Card Scheme on 19th February, 2015 focusing attention on soil health in agricultural areas across the country to enhance productivity through judicious use of inputs, especially fertilizers. An attempt has been made in this study to understand the status and progress of the scheme.

As per the secondary data available on the SHC scheme website (**Table 5.1.1 and Figure 5.1.1**), the target for samples collection is set to be 253.54 lakhs at all India level for cycle -I (2015-16 & 2016-17). At all India, as on 14th March, 2017, the sample collection exceeded the target (>100%) with a record collection of 271.6 lakhs of samples, whereas, in terms of progress on samples tested, the achievement is 81per cent. Similarly, with regard to SHCs printed and distributed, the achievement is less than half of the target (42% and 51%, respectively). The slow progress on soil testing might be due to lack of infrastructure facilities in almost all States. On an average, six SHCs per grid are printed at all India level.

The status of soil testing under SHC scheme across sample States reveals that excepting Punjab and Assam States, the samples collected is more than cent per cent. Whereas, in the case of Punjab and Assam, the achievement in terms of sample collected is comparatively same (64 to

65 per cent). With regard to progress of soil samples tested, none of the State have attained the target, wherein, the achievement is as high as 89 per cent in the case of Karnataka followed by Madhya Pradesh (79%), Bihar (63%) and Maharashtra (52%). Interestingly, the least achievement is again in Punjab and Assam (<35%). Similar to all India trend, the proportion of SHCs printed are less than 50 per cent and a greater proportion (>89%) of them are distributed across States. Only, in the case of Maharashtra, the per cent of SHCs printed are about 79 per cent and almost all are distributed. Excepting Maharashtra, all sample States have printed about six SHCs per grid under this scheme, whereas, the number is five in the case of Maharashtra.

Table 5.1.1: Status of Soil Health Card (SHC) programme across the selected states (as on 14-03-2017)

(Figures in lakhs)

Particulars	Target of samples to be collected	Samples collected	% of samples collected	Samples tested	% progress of soil samples tested	Total Target for Printing & Distribution of SHCs	No. Of SHCs printed per grid	Total SHCs printed	% SHCs printed	Total SHCs Distributed	% SHCs distributed
Karnataka	16.66	16.75	>100.00	14.84	89.08	92.1	6	40.14	43.58	35.54	88.54
Madhya Pradesh	23.14	23.16	>100.00	18.25	78.87	129.77	6	44.21	34.07	43.87	99.23
Maharashtra	23.47	26.15	>100.00	12.17	51.85	127.94	5	101.05	78.98	101.05	100.00
Punjab	8.36	5.35	64.01	2.96	35.41	46.2	6	6.35	13.74	6.35	100.00
Bihar	13.09	13.94	>100.00	8.28	63.25	72.4	6	28.67	39.60	28.67	100.00
Assam	2.79	1.81	64.96	0.51	18.28	15.4	6	1.5	9.74	1.39	92.67
Sample states	87.51	87.16	99.6	57.01	65.15	483.81	6	221.92	45.87	216.87	97.72
All India	**253.54**	**271.6**	**>100.00**	**205.85**	**81.19**	**1399.96**	**6**	**581.89**	**41.56**	**566.25**	**97.31**

Source: http://www.soilhealth.dac.gov.in/progressdpt

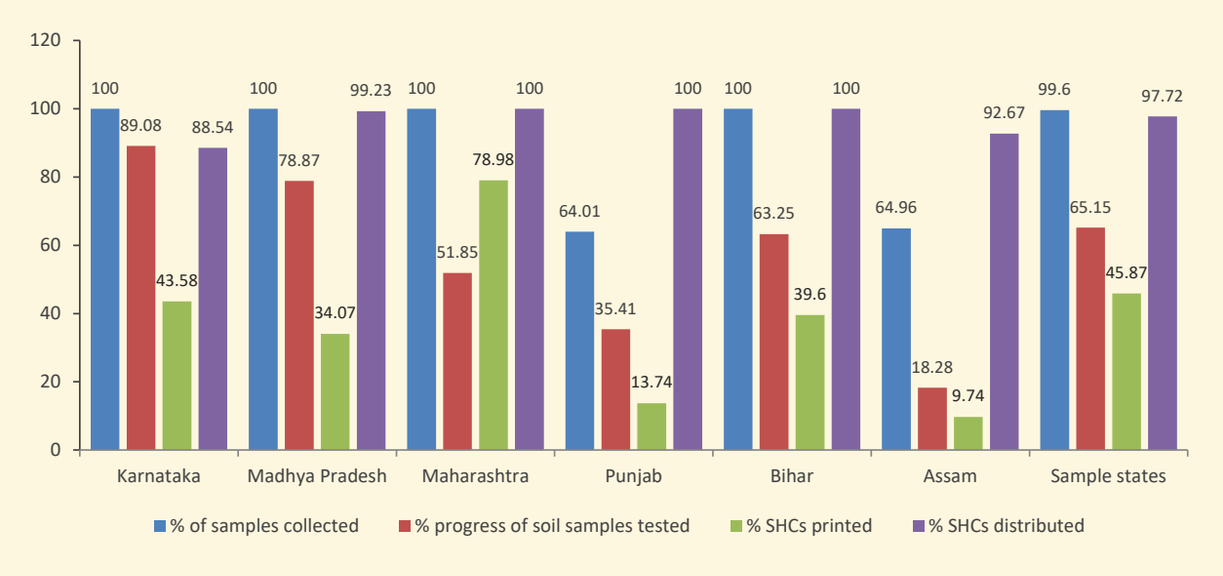


Figure 5.1.1: Status of Soil Health Card (SHC) programme

5.1.2. Details of soil testing

5.1.2.1: Status of SHC Scheme across the sample States and all India

The details of soil testing and related parameters of the respondent farmers are presented in **Tables 5.1.2 and 5.1.3**. A perusal of the tables reveals that, in the last three years, about 34, 28 and 23 per cent of paddy, tur and sugarcane farmers have tested their soil systems as compared to four, two and seven per cent of the respective farmers. Despite the presence of many government schemes such as RKVY, National Project on Management of Soil Health and Fertility (NPMSHF) and Macro Management of Agriculture (MMA), in addition to the State run programmes related to soil testing in almost all the sample states, as for testing of soil systems free of cost, the proportion of farmers who have tested their soil systems at least once is negligible. However, farmers have spent an highest of about Rs.147/- per sample for soil testing in the case of sugarcane crop while a minimum cost incurred is noticed with respect to paddy (Rs. 18/- per sample soil testing). The average distance from the field to soil test laboratories ranges from 20 km to 56 km across these reference crops. On an average, three to five samples are drawn across crops for soil testing. Overall, comparatively, an area of eight to 46 acres has been covered under soil test, as per the details provided by paddy, tur and sugarcane farmers.

Table 5.1.2: Details of soil testing by the paddy, tur and sugarcane respondents

(% of farmers who tested their soil)

Sl. No.	Particulars	Within 3 years			Before 3 years		
		Paddy	Tur	Sugarcane	Paddy	Tur	Sugarcane
1	% of farmers who have done soil testing	28.46	23.00	33.5	6.82	2.00	3.50
2	Number of times soil testing done	1	1	1	1	1	-
3	Cost of soil testing (Rs/sample)	17.86	50.15	147.80	20.00	40.00	78.60
4	Distance from the field to soil testing lab (Kms)	56.48	43.86	33.7	19.83	41.40	30.6
5	Samples taken for soil testing (Nos)	4	3	4	3	3	5
6	Area covered under soil test (all plots) (Acres)	8.46	13.78	45.50	3.33	2.98	50.70

5.1.2. Details of soil testing by the maize, soybean and jute respondents

A perusal of the **Table** (**5.1.3**) reveals that, within the last three years, about 17, 10 and seven per cent of soybean, maize and jute farmers, respectively, have tested their soil systems. The proportion seems to be very less when we look at the picture before three years, wherein, only three per cent of soybean farmers had got their soil systems tested with none of the maze and jute farmers attempting to have their systems at least once. Although the government has been

encouraging farmers to test their soil systems at free of cost, farmers have reported that they had incurred an amount of Rs.15 to Rs. 30/- per sample for soil testing in the case of maize, soybean and jute crops. The average distance from the field to soil test laboratories is found to be the longest (141 km) in the case of jute farmers, and in the case of maize and soybean, the distance ranges from 33km to 39kms. About one to two samples are drawn per plot across crops. Overall, about one to 16 acres have been covered under soil test, as per the details provided by maize, soybean and jute farmers.

Table 5.1.3: Details of soil testing by the maize, soybean and jute respondents

(% of farmers who tested their soil)

Sl. No.	Particulars	Within 3 years			Before 3 years		
		Maize	Soybean	Jute	Maize	Soybean	Jute
1	% of farmers have tested soil	9.50	17.00	6.50	-	3	-
2	Number of times soil testing done	1	1	1	-	1	-
3	Cost of soil testing (Rs/sample)	30.00	14.71	-	-	3.78	-
4	Distance from field to soil testing lab (Kms)	33.33	38.76	141.08	-	39.21	-
5	Samples taken for soil testing (No.s)	2	1	2	-	1	-
6	Area covered under soil test (all plots) (Acres)	1.28	3.14	16.03	-	2.96	-

5.2. Awareness and sources of information on soil testing

5.2.1. Places of soil testing

5.2.1.1. Places of soil testing by paddy, tur and sugarcane respondents

Table 5.2.1.1 reveals that, a majority (81%) of paddy farmers have tested their soil systems at the district laboratories of SDA/ RSKs, while half of the tur farmers are found to have visited SAUs and about 44 per cent district laboratories of SDA/ RSKs for soil testing In the case of sugarcane, a greater proportion of farmers (90%) I observed to have opted for sugar factories for testing their soil systems, while surprisingly, only a small proportion of farmers preferred Krishi Vignan Kendras (KVKs) in their areas for soil testing.

Table 5.2.1.1: Places of soil testing by paddy, tur and sugarcane respondents

(Overall farmers who tested their soil)

Sl. No.	Particulars	Paddy	Tur	Sugarcane
1	Krishi Vignan Kendra (KVKs)	5.78	1.38	-
2	State Department of Agriculture (SDA)/ Raitha Samparka Kendras (RSKs)	81.04	44.43	2.70
3	Private Companies	1.05	-	1.40
4	State Agriculture universities (SAUs)	4.24	50.00	5.40
5	Sugar factories	-	-	90.50
6	Other sources	7.89	4.16	-

5.2.1.2. Places where soil testing was gone through by maize and jute farmers

A majority of maize and jute farmers (52% and 100%) have tested their soil systems at district laboratories of SDA/ RSKs and the rest (47%) of the maize farmers at Krishi Vignan Kendras (KVKs) (Table 5.2.1.2). Surprisingly, no SAUs have been involved in the testing of soil samples.

Table 5.2.1.2: Places where soil testing was gone through by maize and jute farmers

(Overall farmers who tested their soil)

Sl. No.	Particulars	Maize	Jute
1	Krishi Vignan Kendra (KVKs)	47.36	-
2	Raitha Samparka Kendra (RSK) / State Department of Agriculture (SDA)	52.63	100.00

5.2.2. Sources of information on soil testing

5.2.2.1. Different sources of information on soil testing and soil sample collection by paddy, tur and sugarcane respondents

Soil testing is one of the important technologies in agriculture and hence, farmers are educated regarding its importance and usefulness through various sources like State Agricultural Departments, State Agricultural Universities (SAUs), KVKs, private companies, friends, neighbors etc. The details of different sources of information on soil testing among sample farmers are illustrated in **Tables 5.2.2.1 and 5.2.2.2**. It can be observed from **Table 5.2.2.1** that, State Department of Agriculture is the major source (82%) of information on soil testing for tur farmers, while for about 49 per cent of paddy-farmers, the main source of information on soil testing include fellow farmers, seed companies, input dealers etc. However, about 32

per cent of the farmers are found to have received information from more than one sources. Further, the contribution of agriculture department is found to be 15 per cent only. With regard to sugarcane, about 34 per cent got the information about soil testing from officials of SDA, followed by agriculture universities (31%), while about 15 per cent sugarcane farmers from other sources such as input dealers, fellow farmers and seed companies. The rest of the sources are found to have spread awareness among less than 20 per cent each of the farmers growing the reference crops such as paddy, tur and sugarcane. It is obvious that irrigated farmers are more enthusiastic about soil testing and have a better network and hence, they get information more easily as compared to dry-land farmers.

Table 5.2.2.1 represents the collection of soil samples in respect of reference crops. It is revealed from the table, that a higher proportion of farmers has drawn samples on their own in respect of reference crops such as paddy (48%), tur (72%) and sugarcane (77%). The officials of SDA in all the states appear to be the next important source in terms of assisting them in the collection of soil samples, with the proportion of farmers across crops ranging from 10 to 30 per cent. About 21 per cent of paddy farmers also have availed of the services of farmer facilitators in drawing soil samples, while the share seems to be negligible in the case of tur and sugarcane farmers. The other sources such as input dealers, fellow farmers, progressive farmers and private companies have contributed marginally towards the collection of soil samples to be tested.

Table 5.2.2.1: Different sources of information on soil-testing and soil sample collection by paddy, tur and sugarcane farmers

(% of farmers who have tested their soil)

Sl. No.	Sources of soil testing	Paddy	Tur	Sugarcane
1	State Agricultural Universities (SAUs)	0.90	3.18	31.30
2	Krishi Vignan Kendra (KVKs)	1.00	4.68	2.70
3	Private Companies	0.60	7.65	5.40
4	Friends	0.50	1.4	8.10
5	Neighbours	0.90	-	4.10
6	State Department of Agriculture (SDA)	14.70	81.65	33.8
7	More than one source	32.00	-	-
8	Others*	49.40	1.44	14.6
Who collected the soil				
9	Self	48.20	72.00	77.40
10	State Department of Agriculture Officers (RSKs in Karnataka)	29.74	15.00	10.00
11	Farmer Facilitator	20.51	7.00	1.60
12	More than one Organization	1.02	-	-
13	Others*	0.51	6.00	11.00

Note: Others* include private companies, fellow farmers, progressive farmers etc.

5.2.2.2. Different sources of information on soil testing and soil sample collection by maize, soybean and jute respondents

It is noted from **Table 5.2.2.2** that, the SDA is the key source for cent per cent of jute farmers followed by 59 per cent of soybean farmers in terms of spreading awareness regarding soil testing, whereas, in the case of maize, KVKs are the main source (68%) of information on soil testing. The neighbors are the next best source of information on soil testing for about 21 per cent each of the soybean and maize farmers. The other sources such as private companies, friends, and SAUs have also contributed though insignificantly in this respect, especially in the case of soybean farmers in Madhya Pradesh.

The details of soil sample collection are illustrated in **Table 5.2.2.2**. A majority of (74, 44 and 46 per cent) farmers of maize, soybean and jute, respectively are found to have collected their soil samples with the help of farmer facilitators. The officials of SDA have also helped to collect soil samples in respect of more than 54 per cent of jute farmers and 23 per cent of soybean farmers. Interestingly, about 26 per cent of maize farmers and 33 per cent of soybean farmers are found to have collected soil samples on their own.

Table 5.2.2.2: Different sources of information on soil testing and soil sample collection by maize, soybean and jute farmers

(% of farmers who have tested their soil)

Sl. No.	Sources of soil testing	Maize	Soybean	Jute
1	State Agricultural Universities (SAUs)	-	3.01	-
2	Krishi Vignan Kendra (KVKs)	68.42	5.82	-
3	Private Companies	-	8.82	-
4	Friends	-	2.94	-
5	Neighbors	21.05	20.59	-
6	State Department of Agriculture (SDA)	10.53	58.82	100.00
Who collected the soil				
7	Self	26.32	32.59	-
8	State Department of Agriculture Officers (SDA)	-	23.29	53.85
9	Farmer Facilitator	73.68	44.12	46.15

5.3. Reasons for soil testing or not testing

5.3.1. Reasons for soil testing by respondents

5.3.1.1. Reasons for soil testing by paddy, tur and sugarcane respondents

Reasons for soil testing by paddy, tur and sugarcane farmers are presented in Table 5.3.1.1. Out of the soil tested-farmers, understanding the fertilizer requirements of crops is treated as the most important (16%, 81% and 90%) reason by a majority of the paddy, tur and sugarcane respondents, respectively. In addition to this, for a greater proportion of tur (59%) and sugarcane (62%) farmers, not aware of anything about soil testing and its use is the second most important reason for soil testing. Whereas, motivation gained through village demonstrations/ training/ exposure visits to different places is found to have been treated as an important reason by majority of tur (66%) and sugarcane (65%) farmers. 'Poor crop yield' is the third important reason for opting for soil testing for 61 per cent of tur farmers, 57 per cent of sugarcane farmers and 20 per cent of paddy farmers. The other least important reasons cited by paddy, tur and sugarcane farmers include availing of benefits under the subsidy schemes, peer farmer group pressure and others.

Table 5.3.1.1: Reasons for soil testing by paddy, tur and sugarcane farmers

(% of farmers who have tested their soil)

Sl. No.	Reasons	Paddy			Tur			Sugarcane		
		Most important	Important	Least important	Most important	Important	Least important	Most important	Important	Least important
1	Not aware of anything about Soil testing and its use	14.20	15.70	70.10	58.55	19.30	22.15	61.80	38.20	-
2	For availing of benefits under subsidy schemes	05.10	20.30	74.60	8.33	33.33	58.34	66.7	33.3	-
3	Poor crop yield	08.40	20.20	71.40	28.57	60.71	10.71	28.5	57.2	14.30
4	Motivation from village level demonstration/training/ exposure visits to places with best farming practices	10.50	16.70	72.80	4.16	65.37	30.46	29.4	64.7	05.90
5	Peer farmer group pressure	07.00	19.70	73.30	22.72	63.63	13.64	50.0	0.0	50.00
6	To understand the fertilizer requirements of crops	16.00	15.60	68.40	81.65	13.55	4.8	90.6	4.7	4.70
7	Others	00.60	10.40	89.00	43.75	35.41	20.83	-	-	-

5.3.1.2: Reasons for soil testing by maize, soybean and jute respondents

Reasons for soil testing by maize, soybean and jute farmers are presented in **Table 5.3.1.2**. 'Not aware of soil testing', 'availing benefit under subsidy schemes', 'poor crop yield', 'motivation

gained from village level demonstration/training/exposure visits to places', 'peer farmer group pressure', 'understanding the fertilizer requirements of crops' etc are some of the reasons for soil testing as expressed by farmers. Interestingly, it is noticed that, a majority (>90%) of these reasons expressed by maize, soybean and jute farmers are rated as least important. What follows from these results is that although soil test technology is considered as an important tool in the crop production activities, a majority do not have a clear picture of the associated advantages of adopting this technology. Hence, there is a need for educating farmers regarding this technology and encouraging them to adopt, it so as to increase productivity and reduce the cost of cultivation. However, among those reasons, 'understanding the fertilizer requirements of crops' is as treated as the most important reason by maize (4%) and jute (6%) farmers, while, 'poor crop yield' by 14% of soybean farmers.

Table 5.3.1.2: Reasons for soil testing by maize, soybean and jute farmers

(% of farmers who have tested their soil)

Sl. No.	Reasons	Maize			Soybean			Jute		
		Most important	Important	Least important	Most important	Important	Least important	Most important	Important	Least important
1	Not aware of anything about Soil testing and its use	04.00	05.50	90.50	09.00	05.00	86.00	06.00	-	94.00
2	For availing of benefits under subsidy schemes	-	09.50	90.50	10.00	-	90.00	06.50	-	93.50
3	Poor crop yield	02.50	07.00	90.50	14.00	-	86.00	-	06.50	93.50
4	Motivation from village level demonstration/training/ exposure visits to places with best farming practices	02.50	07.00	90.50	10.50	-	89.50	06.50	-	93.50
5	Peer farmer group pressure	04.00	05.50	90.50	-	-	100.00	-	06.50	93.50
6	To understand the fertilizer requirements of crops	04.50	05.00	90.50	-	-	100.00	06.50	-	93.50
7	Others	-	-	-	-	-	100.00	06.50	-	93.50

5.3.2. Reasons for not testing soil by respondents

5.3.2.1. Reasons for not testing soil by paddy, tur and sugarcane respondents

The reasons for not testing their soil systems by farmers of paddy, tur and sugarcane are listed in **Table 5.3.2.1**. A perusal of the table reveals that do not know whom to contact for details on soil testing, do not know how to draw soil samples, soil testing laboratories far away, and soil

testing not required for my field as crop yield is good are the major reasons listed by the non-soil tested farmers across sample States. Out of which, do not know whom to contact for details on soil testing is the most important reason expressed by 33, 82 and 62 per cent of paddy, tur and sugarcane farmers, respectively. More than half of the sample farmers of paddy also treated that do not know how to draw soil samples and soil testing laboratories are located far away are the most important reasons, and the rest are least important. However, with regard to tur and sugarcane farmers, soil testing not required for my filed as crop yield is good, is the second most important reason as revealed by 57 per cent of tur and 83 per cent of sugarcane farmers. Further, about 41 per cent and 57 per cent of tur and sugarcane farmers listed do not know how to draw soil samples as the important reason, in addition to, other most important reasons.

Table 5.3.2.1: Reasons for not testing soil by the control farmers in the study area in respect of paddy, tur and sugarcane crops

(% of farmers who have not tested their soil)

Sl. No.	Reasons	Paddy			Tur			Sugarcane		
		Most important	Important	Least important	Most important	Important	Least important	Most important	Important	Least important
1	Do not know whom to contact for details on soil testing	32.70	08.20	59.10	82.14	10.80	07.06	62.4	18.8	18.8
2	Do not know how to draw soil samples	50.20	00.00	49.80	22.64	41.37	35.99	19.4	56.9	23.6
3	Soil testing laborato-riesare located far away	53.70	02.50	43.80	14.10	44.85	41.05	37.3	36.3	26.4
4	Soil testing not re-quired for my field as crop yield is good	16.20	29.30	54.50	56.26	09.62	34.12	83.6	11.3	05.10

5.3.2.2: Reasons for not testing soil by maize, soybean and jute farmers

Reasons for not testing their soils with respect to maize, soybean and jute respondents are listed in **Table 5.3.2.2**. A perusal of the table reveals that, for more than 90 per cent of jute as well as maize farmers, 'do not know how to draw soil samples', and 'soil testing laboratories are located far away' are the most important reasons, followed by 'do not know whom to contact for details on soil testing' (>50%). Whereas, with respect to soybean, 'soil testing laboratories are located far away', 'soil testing not required for my field as crop yield is good', and do not know whom to contact for details on soil testing' are the most important reasons' as expressed by 61 per cent, 46 per cent and 42 per cent of farmers in the order of importance.

Table 5.3.2.2: Reasons for not testing soil by the control farmers in the study area in the case of maize, soybean and jute crops

(% of farmers who have not tested their soil)

Sl. No.	Reasons	Maize			Soybean			Jute		
		Most important	Important	Least important	Most important	Important	Least important	Most important	Important	Least important
1	Do not know whom to contact for details on soil testing	73.00	17.50	09.50	41.50	17.00	41.50	49.50	43.50	07.00
2	Do not know how to draw soil samples	90.50	-	09.50	24.50	29.50	46.00	93.00	-	07.00
3	Soil testing laborato-ries are located far away	90.50	-	09.50	60.50	21.50	18.00	93.00	-	07.00
4	Soil testing not re-quired for my field as crop yield is good	13.00	07.00	80.00	45.50	32.50	22.00	-	93.00	07.00

5.4. 5.4. Adoption of recommended doses of fertilizer (RDF) application based on soil test report

5.4.1. Elucidation of RDF with respect to reference crops

The main objective of soil test technology is to determine nutrient content, composition and other properties of soil systems such as pH level, Electric Conductivity (EC), etc., whereas, Soil Health Card Scheme aims at promoting Integrated Nutrient Management (INM) through a judicious use of chemical fertilizers (both micro and macro nutrients) in conjunction with organic manures and bio-fertilizers for improving the overall soil health and its productivity. These characteristics are analysed through soil testing. In addition to all other soil characteristics, the fertilizer requirements of the next crop are recommended, which, are called as 'Recommended Doses of Fertilizers' (RDF), taking into consideration, the nutrients already present in the soil systems. An effort has made in this section to understand, the sources of information, awareness and educational level of farmers on the information provided in SHCs among sample farmers in the study area.

5.4.1.1. Elucidation of Recommended Doses of Fertilizers (RDF) with respect to paddy, tur and sugarcane crops

It is evident from **Table 5.4.1.1** that, out of soil-tested farmers, about 19% of paddy, 14% of tur and 36% of sugarcane farmers are aware of RDFs provided in the SHCs. Among these farmers, a majority (48% of paddy and 57% of tur farmers), are found to have received RDF- related guidelines from the officials of SDAs, whereas, in the case of sugarcane, a majority (34%) are aware of RDFs based on their own experience. However, in the case of paddy and tur, fellow farmers (14% and 21%) and in respect of sugarcane, officials of SDA (18%) also have educated the farmers regarding RDFs based on SHCs. About 27 per cent of paddy farmers also have revealed

that they received information from more than one sources. The rest of the sources such as SAUs, Cooperatives, Private dealers, sugar factories are found to have explained to paddy, tur and sugarcane farmers regarding RDFs to an extent of 15 per cent each.

Table 5.4.1.1: Elucidation of Recommended Doses of Fertilizers (RDF) with respect to paddy, tur and sugarcane respondents

((% farmers following RDFs)

Sl. No.	Who explained to you	Paddy	Tur	Sugarcane
1	% of farmers aware of RDF	19.10	14.50	36.50
2	State Department of Agriculture (SDA)	47.64	56.85	17.80
3	State Agriculture University (SAU)	5.75	-	1.40
4	Cooperatives/growers association	-	1.00	5.50
5	Private dealers/retailers	5.75	18.65	9.60
6	Fellow farmer	13.61	20.60	16.40
7	Own experience	-	-	34.20
8	Multiple sources	27.25	-	-
9	Sugar factories	-	-	12.30
10	Others	-	2.90	2.70

5.4.1.2. Elucidation of Recommended Doses of Fertilizers (RDF) with respect to maize, soybean and jute crops

It is evident from **Table 5.4.1.2** that, out of the soil-tested farmers, about 26% of maize and 13% of jute farmers are aware of RDFs on the basis of information provided in the SHCs. Among these farmers, 37% of maize and 58 % of jute farmers are found to have received RDF-related explanations from the officials of SDA. However, about 28 per cent and 38 per cent of maize and jute farmers also are found well-informed by multiple sources on RDFs based on SHCs. In the case of soybean, about 34 per cent farmers got information on RDFs from SAUs, while about four per cent of jute farmers have expressed that fellow farmers helped them understand the RDFs provided in SHCs.

Table 5.4.1.2: Elucidation of Recommended Doses of Fertilizers (RDF) with respect to reference crops

((% cent of farmers following RDFs)

Sl. No.	Who explained to you	Maize	Soybean	Jute
1	% of farmers aware of RDF	26.50	-	13.00
2	State Department of Agriculture (SDA)	37.73	-	57.69
3	State Agriculture University (SAU)	33.97	-	-
4	Fellow farmer	-	-	3.84
5	Multiple sources	28.30	-	38.47

5.4.2. Recommended doses of fertilizers adopted by the sample farmers

Although soil testing has been carried out by meager proportion of the sample farmers, most of them have not received SHCs on time. Moreover, out of the SHCs received, many have not kept them as an important document for application of recommended doses of fertilizers. Out of the farmers, who have kept SHCs and are following the recommendations are few in number. A few of them have revealed that they are aware of RDFs and can recall them based on information given in the SHCs. Hence, we have documented RDFs as revealed by farmers and as reported in the SHCs, and the relevant details are given in **Tables 5.4.2.1 and 5.4.2.2.**

5.4.2.1. Recommended doses of fertilizers adopted by paddy, tur and sugarcane respondents

It is evident from **Table 5.4.2.1** that, in the case of paddy, a majority have perceived that the fertilizer requirements are less as compared to RDFs given in SHCs. As per them, the average quantity of urea recommended works out to 87 kg per acre, whereas, it is 154 kg per acre as mentioned in the SHC. The perceived DAP quantity is much higher than the recommended quantity in SHCs, whereas, it is vice-versa with respect to MOP. Moreover, FeSO4 and Sulphur are not at all recommended in SHCs, while both are perceived by the paddy-farmers. Although, SSP and lime are recommended in large quantities in the SHCs, none of the paddy farmers is found to have followed the same.

Table 5.4.2.1: Recommended doses of fertilizers adopted by paddy, tur and sugarcane farmers

Sl. No.	Particulars	Paddy		Tur		Sugarcane	
		As per Farmer Opinion	As per Soil Test Report	As per Farmer Opinion	As per Soil Test Report	As per Farmer Opinion	As per Soil Test Report
1	FYM (ton/ac)	08.41	08.06	01.05	00.55	4	4.60
2	Urea (kg/ac)	87.48	153.52	35.30	15.20	231.2	262.1
3	DAP (Kg/ac)	52.81	01.64	47.05	21.10	112.4	111.1
4	MOP (Kg/ac)	29.21	64.09	12.30	12.65	113.7	146.6
5	ZNSO4 (kg/ac)	-	00.97	02.75	00.45	-	-
6	FeSo4 (kg/ha)	10.62	-	00.15	01.75	0.50	1.80
7	Sulphur	40.72	-	-	-	-	0.90
8	SSP	-	128.50	-	-	18.9	1.80
9	Lime	-	760.58	-	-	-	-
10	Mgso4	-	-	-	-	0.40	9.80
11	Nimbodi	-	-	-	-	0.80	-
12	Others (kg/ac)	-	00.28	-	-	44.8	37.7

With regard to tur, the recommended quantities of NCU and DAP are prejudged as double the quantity mentioned in SHCs, while MOP is relatively the same as mentioned by the farmers and recommendations. The other nutrients are on a little higher side relative to those mentioned in the SHCs. With respect to sugarcane farmers, a majority of the nutrients are found on par with the recommendations in the SHCs. The quantity guessed by farmers is seems to be on a little higher side in the case of urea, MOP and MgSo4, mainly because they are found applying lesser quantity.

5.4.2.2. Recommended doses of fertilizers adopted by maize, soybean and jute respondents

It is observed from **Table 5.4.2.2** that, in the case of maize, the recommended nutrients include NU/NCU and DAP only as per SHCs, whereas, farmers perception is that the recommendations include FYM, Urea, DAP, MOP, MgSO4, and others. Interestingly, they are found to have applied almost the same quantity of Urea and DAP. With respect to soybean, most of the farmers perception is that the fertilizer requirements are less as compared to RDFs mentioned in SHCs in terms of FYM and SSP, while, two times in the case of NU/NCU, MOP, and ZnSO4. More or less the same quantity of DAP is recalled. On the contrary, jute farmers perceive a higher quantity of DAP, less of urea and MOP, while SSP is relatively the same as recommended.

Table 5.4.2.2: Recommended doses of fertilizers adopted by maize, soybean and jute farmers

Sl. No.	Particulars	Maize		Soybean		Jute	
		As per Farmer Opinion	As per Soil Test Report	As per Farmer Opinion	As per Soil Test Report	As per Farmer Opinion	As per Soil Test Report
1	FYM (ton/ac)	10.00	-	6	10	4.07	3.30
2	Urea(kg/ac)	119.03	122.90	27.56	10	35.50	37.70
3	DAP(Kg/ac)	24.09	24.15	49.18	52.00	73.87	-
4	MOP (Kg/ac)	24.19	-	37.27	13.00	30.25	19.55
5	ZNSO4 (kg/ac)	-	-	5.45*	10*	-	-
6	SSP	-	-	18	100	72.60	72.60
7	Mgso4	15.00	-	-	-	-	-
8	Others(kg/ac)	5.00	-	-	-	-	-

Note: *Once in three years

5.5. Problems faced in soil testing and suggestions for improvement in SHC scheme

5.5.1. Problems faced by farmers in respect of soil testing

The major problems faced by the sample farmers in respect of soil testing are listed in **Table 5.5.1**. It is observed from the table that SHCs are not distributed on time which is a major problem as reported by 52, 23, 30 and 61 per cent of paddy, tur, maize and sugarcane farmers, respectively. Lack of information on soil test technology is the second important issue raised by cent per cent of soybean farmers, 14 per cent of sugarcane farmers and 16 per cent of paddy farmers across the sample States. 'Lack of information flow from government departments' followed by 'soil testing laboratories are located far away' are the major issues under SHC scheme as expressed by 50 per cent of soybean farmers and 63 per cent of jute farmers in Assam, respectively. 'Samples of soils are not collected from the individual fields' is also a complaint registered by 29 per cent of maize and 37 per cent of jute farmers. On the other hand, about 27 per cent of tur and 45 per cent of sugarcane farmers have expressed that there are no problems in respect of SHC scheme. The other problems such as KVKs charging fees for soil testing, difficulty in understanding RDFs with the available fertilizers in the market, high cost of RDFs etc., account for less than 10 per cent of farmers growing from each crop.

Table 5.5.1: Major problems faced by farmers in respect of soil testing

((% of soil-tested farmers)

Sl. No.	Problems	Paddy	Tur	Sugarcane	Maize	Soybean	Jute
1.	Soil testing laboratories are far away	12.08	13.51	41.50	26.50	13.00	63.00
2.	Lack of awareness regarding soil sam-pling	9.11	17.00	0.00	-	25.00	-
3.	SHCs are not distributed on time	52.48	23.47	1.00	30.00	61.00	-
4.	No training facilities	5.36	20.81	-		24.00	-
5.	Lack of information on soil test tech-nology	15.62	-	14.00	11.00	100.00	-
6.	Do n' t know whom to contact for de-tails on soil testing	20.48	-	1.50	-	-	-
7.	Lack of information flow from Govt. Departments	13.07	-	-	-	50.00	-
8.	KVKs charge fees for soil testing	7.12	-	-	18.50		-
9.	Allotment of wrong identification num-bers (due to technical faults during soil sampling under Grid system) SHCs are not received	3.37	-	-	8.50	-	-
10.	High cost of RDFs	4.75	-	-	-	21.00	-
11.	Difficulty in understanding RDFs with the available fertilizers	5.75	-	-	-	17.00	-
12.	Samples of soils are not collected from individual fields	9.37	-	-	28.50	-	37.00
13.	Unable to report any problem	1.25	27.00	44.50	-	-	-

5.5.2. Suggestions for improving the SHC scheme

Major suggestions for improving the SHC scheme are illustrated in **Table 5.5.2.** It is observed from the table that spreading of awareness among the farming community regarding soil test technology is the key suggestion made by 51, 31, 20, 21 and 58 per cent of paddy, tur, sugarcane, maize, and soybean farmers, respectively. The need for establishing soil test laboratories at each taluk level is the second important suggestion offered by farmers from growing all the sample crops, with a greater proportion (54% & 100%) of soybean and jute farmers subscribing to the represented the same suggestion. The need for organizing trainings on soil sampling is the other suggestion made by 81 per cent of soybean and 24 per cent of paddy farmers. Arrange for receipt of soil sampling under the grid system, collection of soil samples may be arranged on a participatory basis, extension contact should be improved etc., are the other major suggestions made by a negligible proportion of farmers growing paddy, maize and soybean crops.

Table 5.5.2: Major suggestions for improving the SHC scheme

(% of farmers)

Sl. No.	Suggestions	Paddy	Tur	Sugarcane	Maize	Soybean	Jute
1.	Need to organize trainings on soil sampling	24.19	1.82	3.00	-	81.00	-
2.	Access to free and timely SHC distribution	36.72	14.63	21.00	34.50	81.00	-
3.	Need to spread awareness regarding soil test technology	51.37	31.31	20.00	21.00	58.00	-
4.	Access to soil test report information through mobile phones	22.34	-	-	17.00	-	-
5.	Establish soil test laboratories at each taluk level	29.03	17.26	10.00	33.00	54.00	100.00
6.	Arrange for receipt of soil sampling under grid system	8.75	-	-	22.00		-
7.	Collection of soil sample may be made on participatory basis	8.25	-	-	36.00	-	-
8.	Extension contact should be improved	13.62	-	-	-	28.00	-
9.	SHC reports should be available in the local/regional language	9.00	-	-	-	54.00	-
10.	No suggestion and can't say	-	61.50	48.50	-	-	-

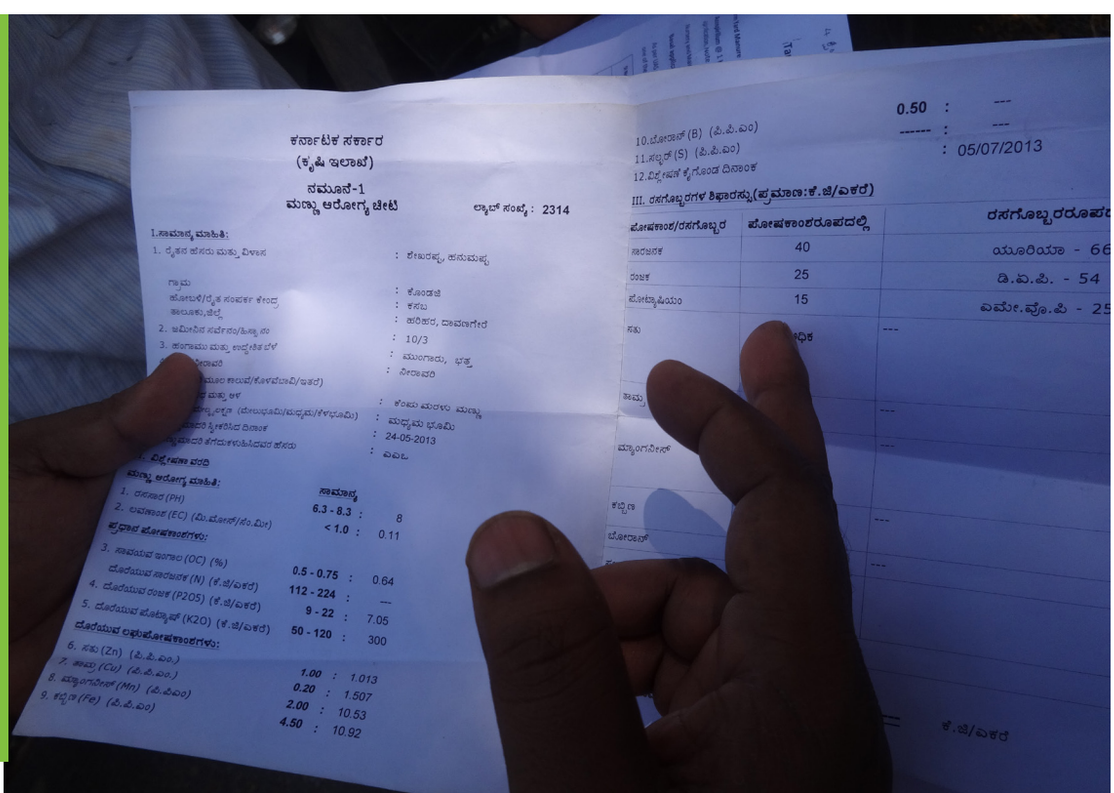
5.6. Summary of the chapter

It is noticed from the available secondary information that at macro level, the soil sample collection has exceeded the target, whereas, in terms of progress made in the testing of samples

the achievement amounts to 81per cent of the target set. With regard to the printing and distribution of SHCs, the achievement is less than half of the target (42% and 51%, respectively). More or less, a similar situation is observed across States. The slow progress made in respect of soil testing might be due to the lack of infrastructure facilities in almost all the States. It is also found that in the last three years, less than 35 per cent of farmers across reference crops have tested their soil systems, despite the presence of various programmes for testing soils free of cost. A majority of the farmers have preferred district laboratories of SDA/ RSKs and KVKs for testing their soil systems in respect of almost all the crops, excepting sugarcane, with majority of the farmers opting for sugar factories. SDA/ RSKs are the key source of information on soil testing across crops, followed by KVKs and farmer facilitators.

Understanding the fertilizer requirements of crops is treated as the most important reason by a majority of the respondents, followed by motivation gained through village demonstrations/ training/ exposure visits to different places and poor crop yield for having their soil tested. On the other hand, 'do not know how to draw soil samples' and 'soil testing laboratories are located far away' followed by 'do not know whom to contact for details on soil testing' are the most important reasons for not testing their soils. Out of soil-tested farmers, about 19 per cent of paddy, 14 per cent of tur, 36 per cent of sugarcane, six per cent of maize and 13 per cent of jute farmers are aware of RDFs on the basis of information provided in the SHCs. Among these farmers, a majority have received RDF-related guidelines from the officials of SDA followed by private input dealers. Very negligible proportion farmers are aware of RDFs on SHC basis, though they tend to apply fertilizers on 'recall' method. As regards the major problems faced by them and suggestions on SHC scheme, SHCs are not distributed on time and lack of information on soil test technology are the main problems reported by the sample farmers. At the same time, ensuring access to free and timely SHCs, establishing of soil test laboratories at each taluk level and the need for organizing trainings on soil sampling are the most important suggestions made by these farmers.

Sample Soil Health Card in Karnataka



6. Impact of NCU and Soil Health Card Scheme, On Production, Productivity and Soil Health

An impact evaluation is an economic measurement of changes with respect to certain variables that can be attributed to a particular intervention in general and NCU intervention, in particular. Carrying out such an analysis requires factual data collection at the appropriate time and place, often using statistical methods. It is a comparison of what actually has happened and what would have happened in the absence of NCU intervention. The present study used two approaches, for analysis. First, before and after intervention of NCU approach (before-after approach). Secondly, with (NCU farmers) and without intervention of NCU (NU Farmers) approach. In this study, the mean outcome related to NCU users has been compared with the mean outcome for NU users, in addition to changes noticed before and after the intervention of NCU. It pertinent to note here that the observed changes cannot be entirely attributed to NCU intervention, considering that other external factors may have also been partly or wholly responsible for the changes, or may have even act to offset the positive impacts of NCU intervention.

Chemical fertilizers are the immediate source of nutrients for soils as they act as a vital input for the growth of agricultural crops and also they assume a greater significance from the view point of attaining self-sufficiency in food grain production. Considering that in addition to the primary nutrients (‘N’, ‘P’, ‘K’), the secondary and micro-nutrients are also required for plant growth, the government policies, since independence, have been directed towards regulating the sale, prices and distribution of fertilizers with the objective of encouraging investment in the fertilizer industry and ensuring the availability of fertilizers at affordable prices through payment of subsidies, as an incentive as part of the larger goal of maximizing agricultural production in the country. With the initiation of economic reforms, the government began decontrolling the prices and distribution of fertilizers, excepting urea. This resulted in an increased consumption of N fertilizers and reduction in the use of P and K fertilizers. The New Pricing Scheme, implemented in 2003, was a concession scheme for urea, which further increased the distortions in the NPK consumption pattern. In 2010, to promote a balanced use of fertilizers, a Nutrient Based Subsidy scheme was announced, according to which, the government would fix subsidy on an annual basis, based on the weights of different macro/ micro nutrients in fertilizers. However, since the scheme did not cover urea, no self-sufficiency in urea production could be achieved, reflected in steady rise in its consumption since 2003-04. This led to a widening gap between production and consumption, forcing the government to increase its urea imports.

In order to make urea available at affordable prices to farmers, the government implemented Investment Policy for urea in 2012. With the revised energy consumption norms, to make

urea production energy-efficient and to rationalize the subsidy burden and also to increase its production, the Government made mandatory the production (100%) of Neem Coated Urea (NCU) domestically and the coating of imported urea with neem since May, 2015. Considering that the NCU use characterized by a slow release of nitrogen, its consumption should be less, as compared to Normal Urea (NU). Moreover, as NCU cannot be used for industrial purposes, the illegal diversion of subsidized urea to non-agricultural uses could be curbed (**GoI, 2016b**). In fact, this policy is expected to help the government save money to the tune of Rs.6500 crore given away in the form of subsidies, annually.

Against this background, the present chapter discusses the field based observations relating to the impact of NCU usage vis-à-vis NU, on the productivity/production of reference crops such as paddy, maize, tur, sugarcane, jute and soybean across the sample states. The major impact parameters used in the study are both quantitative and qualitative in nature. The quantitative parameters include the yield levels of both the main product and by-product, fertilizer quantity applied, cost of cultivation, income levels etc. On the other side, the qualitative aspects cover the perceptions of farmers regarding comparative, qualitative and relative benefits of NCU usage vis-à-vis NU and the impact of soil testing technology (SHC scheme) and the use of NCU on the different characteristics of the soil systems. A partial budgeting framework and a Paired unequal sample 't' test (with respect to NCU and Non-NCU farmers for the year 2015) have been employed for observing the significant difference between the two categories of farmers with respect to various indicators. The results are discussed under the following sub-headings:

6.1. Impact of NCU on production and marketing of reference crops

6.2. Impact of NCU on the cost of cultivation of reference crops

6.3. Economic feasibility of NCU using a partial budgeting framework

6.4. Comparative, qualitative and relative benefits of NCU usage vis-à-vis NU

6.1. Impact of NCU on production and marketing of reference crops

6.1.1. Impact of NCU on production and marketing of paddy

Paddy being India's pre-eminent crop forms the staple food for a large proportion of the country's population. Further, India is one of the world's largest producers of paddy (white rice and brown rice) with a 20 per cent share in the world's paddy production. During the reference period (Kharif 2015), both NU and NCU were available in the market across the study area before the government made mandatory the production (100%) and distribution of NCU throughout the country. Therefore, an effort was made by the study to compare the impact of NU and NCU on the production and productivity of the reference crops across states in India.

The details of the impact of NCU on production and marketing of paddy are presented in **Table 6.1.1**. At the aggregate level, the average main product yield of paddy is found highest in the case of NCU users (22.52 quintals/acre) as compared to NU users (20.90 quintals/acre), which accounts for a statistically significant increase in yield of 7.75 per cent. This is due to the presence of neem content in urea, which slows down the release of nitrogen and as a result, 'N' is available to plants for a longer period as compared to NU and concomitantly reduces the frequency of application and consumption of urea fertilizer. These results are conform to the study findings conducted by **John *et.al.*, (1989)** who found a significant increase in grain yield of rice in their successive field experiments. However across states, the scenario seems to be different with the increase in yield levels of paddy being much more than the aggregate figures in the case of Madhya Pradesh (16.58%), followed by Karnataka (10.83%) and Bihar (9.42%) in the order of importance, while the increase is less observed in respect of Assam (5.34%) and Punjab (0.97%). All these results are found statistically significant at about five per cent level.

Similarly, in terms of by-product yield, the aggregate yield shows an increase from 31.59 quintals/ acre to 32.41 quintals/ acre post the application of NCU in place of NU. This increase in the by-product yield amounts to 2.59 per cent as compared to the yield levels in the context of NU application. Across different states, the highest per cent change in by-product yield is noticed in the state of Bihar (7.60%), followed by Madhya Pradesh (5.28%), Assam (5.41%), Punjab (3.45%), and Karnataka (3.45%). This increase in yield is found to be statistically significant.

Excepting Karnataka, the prices of the main product appear to be relatively the same across States and all India. The per cent change over post NCU application in the place of NU varies within two percent, whereas, only in the case of Karnataka, the prices seem to have decreased to the tune of 0.33 per cent which may be due market imperfections. Overall, there is an increase in the main product price to an extent of rupees eight per quintal with respect to NCU, indicating the percentage change at 0.58 per cent. Similarly in the case of by-product price, the per cent change in respect of NCU as compared to NU amounts to 8.98 per cent. The increase in the price of by-product from Rs.167/ bundle (without NCU) to Rs. 182/ bundle (with NCU) might be attributed to the application of NCU in addition to many other factors. Further, a majority of the farmers also have reported an increase in the quality of both the main product and by-product yields post NCU application. With respect to statistical significance, a most of the prices across States appear to be non-significant. Depending upon the prices of both the main product and by-product, the value of main product and by-product shown an increase of 8.23 per cent and 23.87 per cent, respectively, post the adoption of NCU in place of NU at the aggregate level. Like the prices of the main product and by-product, a most of the prices across states and all India are found statistically non-significant in the case of paddy, excepting Assam and Madhya Pradesh, in respect of which the prices are found statistically significant at one per cent level for both the values of the main product and by-product.

Table 6.1.1: Impact of NCU on production and marketing of Paddy

(Quintals/Acre)

Sl. No.	Particulars	Karnataka		Assam		Bihar		Madhya Pradesh		Punjab		All India	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Main product yield (quintal)	28.94	26.11** (10.83)	13.80	13.10*** (5.34)	26.82	24.51** (9.42)	14.06	12.06*** (16.58)	29.00	28.72*** (0.97)	22.52	20.90*** (7.75)
2	By-product Yield (quintal)	62.37	60.29* (3.45)	8.97	8.51*** (5.41)	4.67	4.34** (7.60)	23.69	22.50* (5.28)	62.35	58.14* (7.24)	32.41	31.59Ns (2.59)
3	Price of main product (Rs/ quintal)	1804	1810 NS (-0.33)	1137	1122** (1.33)	1093	1089Ns (0.36)	1382	1354Ns (2.06)	1450	1450NS (0.00)	1373	1365*** (0.58)
4	Price of by-product (Rs/ quintal)	84	71NS (18.30)	350	350NS (0.00)	199	198Ns (0.50)	155	120Ns (29.16)	120	98** (22.44)	182	167** (8.98)
5	Value of main product (Rs)	52,208	47268NS (10.47)	15691	14698*** (6.75)	29314	26691** (9.82)	19431	16329*** (18.99)	42050	41644** (0.97)	31740	29326Ns (8.23)
6	Value of by-product (Rs)	5,248	4,289*** (22.36)	3139	2979*** (5.37)	929	859Ns (8.15)	3672	2700*** (36.00)	7482	5697.72* (31.31)	4094	3305Ns (23.87)

Note: ***, ** & * indicate 1, 5 and 10 per cent level of Significance, respectively;
Figures in parentheses indicate percentage change

6.1.2. Impact of NCU on yield levels of tur/ redgram

Pulses are rich in proteins and are found to be the main source of protein to vegetarian people. India is the largest producer, largest consumer and the largest importer of pulses in the world, with an area of around 24-26 million hectares and a production of around 17-19 million tonnes annually (NCAER 2014-15). India accounts for over one third of the world's total area under pulses and 20 per cent of the world's total production.

Table 6.1.2 presents the impact of NCU on production and marketing of tur/ Redgram. Overall, like paddy, a higher productivity of tur is noticed in the case of farmers applying NCU (3.5 quintals/acre) in place of NU (2.62 quintals/acre), whereas, the percentage change in yield levels post the application of NCU in place of NU amounts to as high as 33.58 per cent. This increase in yield pattern observed across the sample households is in line with the yield pattern observed by the Ministry of Agriculture and Farmers Welfare, Govt. of India for 2014-15. From among the selected states, for tur/redgram, the highest yield is observed in the case of Maharashtra (5.0 quintals/acre among the users of NCU and 3.20 quintals/acre among the users of NU) due to favourable climatic conditions during Kharif 2015. However, in the case of Karnataka a decreasing yield is noticed with respect to both the users of NCU and NU (2.0 & 2.04 quintals/acre), which is almost half of the tur/ redgram yield observed in Maharashtra. The

low yield observed in the case of tur/ redgram in Karnataka is mainly due to consecutive severe drought conditions/ deficit rainfall in the tur growing areas of the state. Interestingly, the yield levels are found statistically significant for both Maharashtra and Karnataka, non-significant at the aggregate level though.

Similarly, the average by-product yield shows an increase from 1.93 quintals/acre (with the application of NU) to 2.38 quintals/ acre post the application of NCU, which accounts for a 23.31 per cent increase in yield level with the results being found statistically significant. As for as a state-wise analysis is concerned, the by-product yield found highest in respect of Karnataka (2.37 and 2.47 quintal/acre) as compared to Maharashtra (2.40 & 1.40 quintals/acres) among the users of NUC in place of NU, respectively. Although, there is a difference in the by-product yield levels, it is not statically found significant.

It is observed from the results that the prices of the main product are lower to an extent of Rs. 400-1200 per quintal in the case of Karnataka as compared to Maharashtra for the reference period. Interestingly, a decrease in prices of tur/ redgram, is observed with the application of NCU and NU, for the reference period. The price- difference ranges from two to three per cent across states, which might be due to market imperfections. At the aggregate level the prices of main product show a decline to an extent of 2.38 per cent for users of NCU with the results being found statistically non-significant, whereas, in the case of by-product of tur/ redgram, there exist huge price variations. The prices of by-products are very much low in the case of Karnataka in comparison to Maharashtra and similar is the case with the users of NCU and NU. Accordingly, the aggregate by-product prices are found negative to an extent of 11.86, however, these figures are found statistically significant at one per cent level.

Due to an increase in the yield levels of the main product and by-products of tur/ red gram in Maharashtra, the aggregate picture shows an increase in the values of main product and by-products to the tune of 32.23 per cent and 38.15 per cent post the application of NCU in place of NU. On the other side, the increase is more than double in the case of value of main product and more than 40 per cent with respect to the value of by-product in Maharashtra state and these figures are found statistically significant. However, with respect to Karnataka, because of a decrease in the main product yield and prices, the value of main product shows a decrease to an extent of four per cent, whereas, a decrease in the yield of by-product and an increase in the prices, the value of by-product has jumped to about 29.50 per cent, which is found significant at 10 per cent level.

Table 6.1.2: Impact of NCU on production and marketing of Tur

(Quintals/Acre)

Sl. No.	Particulars	Karnataka		Maharashtra		All India	
		NCU	NU	NCU	NU	NCU	NU
1	Main product yield (quintal)	2.00	2.04** (-1.96)	5.0	3.2*** (56.25)	3.5	2.62Ns (33.58)
2	By-product Yield (quintal)	2.37	2.47NS (-4.04)	2.4	1.4 NS (71.42)	2.38	1.93* (23.31)
3	Price of main product (Rs/ quintal)	7627.33	7790.17** (-2.09)	8,807	9,046 ** (-2.64)	8217	8418Ns (-2.38)
4	Price of by-product (Rs/ quintal)	156.55	115.99*** (34.96)	705	863 *** (-18.30)	431	489*** (-11.86)
5	Value of main product (Rs)	15254.66	15891.94NS (-4.01)	44035	28947 ** (52.12)	29645	22419Ns (32.23)
6	Value of by-product (Rs)	371.02	286.49* (29.50)	1692	1,208 *** (40.06)	1032	747*** (38.15)

Note: ***, ** & * indicate 1, 5 and 10 per cent level of significance respectively.
Figures in parentheses indicate percentage change

6.1.3. Impact of NCU on production and marketing of jute, maize, sugarcane and soybean crops

The details of the impact of NCU on production and marketing of jute, maize, sugarcane and soybean are illustrated in **Table 6.1.3**. The crop-wise details are discussed as follows:

Jute is the second important fibre crop in India, next to cotton. Jute is in great demand because of its cheapness, softness, strength, length, luster and uniformity of its fibre. The area under jute cultivation varies from 0.8 million to 0.9 million hectares in the country. India is the largest producer and consumer of jute in the world. The major producer states in the country include Uttar Pradesh, Bihar, Andhra Pradesh, West Bengal, Odisha and Assam. It is observed from the Table 6.1.3 that jute has yielded an higher quantity of production post the application of NCU (8.86 quintals/ acre) as compared to NU (8.60 quintals/ acre), showing a significant change in the main product yield. This increase in the yield level works out to three per cent post the adoption of NCU over NU, whereas, in the case of by-product yield, no difference in yield levels is noticed

in respect of Assam. As for the prices of both the main product and by-product, there is no significant difference observed in the case of jute. Moreover, the prices are found statistically non-significant. Because of an increase in the yield levels of jute due to NCU application, the value of the main product shows an increase to the tune of 2.47 percent vis-a-vis of NU and is found statistically significant at five per cent level, while, no change is noted with respect to the value of by-products.

Maize, cultivated over nearly 178 million hectare globally across 160 countries contributes 50 per cent (1,170 million MT) to the global grain production. In the Indian context, maize constitutes about nine per cent of the total volume of cereals produced and hence, it is the third most important food grain after rice (42%) and wheat (38%) (NCDEX report-2015). The paired sample t -test results indicate that the main product yield, values of the main product and by-product are significantly higher in the case of NCU farmers as compared to the users of NU. The main product yield shows an increase from 23.38 quintal/acre with respect to NU users to 25.25 quintal/acres in the case of NCU users. Thereby, it indicates the percentage change in the yield due to NCU over NU at 7.99 per cent. However, there is almost no change observed in the case of by-product yield of maize in the study area. On the contrary, there is a small decrease in the prices of main product (Rs. 27/ quintal) and an increase in the prices of by-product (Rs. 7/- per quintal) in respect of maize produced by the users of NCU as compared to the users of NU. Consequently, the values of the main product and by-products of maize show an increase to an extent of five per cent each, for the users of NCU in place of NU.

Sugarcane is an important commercial crop of the country occupying around 3.8 million hectares with a production of 270 million tonnes. It accounts for about three per cent of the cultivated area and eight per cent of the agricultural production in the country. Further about 35 million farmers are dependent on sugarcane for their livelihood. The impact of NCU on Production and marketing of sugarcane is presented in **Table 6.1.3**. It is very clear from the table that, there is a significant change in the yield, price and value of the main product for the users of NCU as compared to the users of NU. The main product yield has increased from 513 quintal/acre to 539 quintals/acre post the application of NCU, which accounts for 5.06 per cent. Similarly, the percentage change in the price of the main product post the application of NCU in place of NU constitutes 2.31. Overall, the percentage change in the value of the main product post the adoption of NCU works out to 7.50. As regards the by-product, although there exist differences in the price and value, the results are found statistically insignificant.

Soybean has become an important oilseed crop in India over a very short period with approximately 10911 thousand hectares of area, and a production of 10374 thousand tonnes per year (MoA & FW, GOI, 2015-16). The major soybean growing states include Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Andhra Pradesh, and Chhattisgarh. The Impact of NCU on production and marketing of soybean is presented in **Table 6.1.3**. A perusal of the table reveals a higher yield

to the tune of 37.82 per cent in the case of NCU users (5.32 quintals/acres) as compared to the NU users (3.86 quintal/acre). Similarly, the by-product yield of soybean shows a marginal increase (0.8 tonnes/ acre) from 7.18 quintals/ acre, for the users of NU to 7.98 quintals /acre for the users of NCU, which accounts for 11.14 per cent increase in yield. This increase in yield can be attributed to NCU application in addition to better management practices followed by soybean farmers in Madhya Pradesh. Hence, the yield of soybean for the selected households is higher than the national average yield (380 kg/acre) (MoA & FW, GOI, 2015-16). However, the prices of the main product and by- product show a mixed trend in that, the price of the main product is marginally lower (Rs.3151 to Rs.3595/quintal) with respect to NCU vis-a-vis NU users, while at the same time, the price of by-product shows an increase from Rs. 163/quintal to Rs. 179/quintal in the case of NCU vis-a-vis NU users. As a result, the change in the values of the main product and by-product amounts to 20.80 and 22.05 per cent, for users of NCU relative to NU users respectively in the case of soybean-farmers in Madhya Pradesh. This implies that the increase in the yield of soybean is the result of a direct or indirect influence of the NCU usage in addition to other favourable factors.

Table 6.1.3: Impact of NCU on production and marketing of jute, maize, sugarcane and soybean crops

(Quintals/Acre)

Sl. No.	Particulars	Assam (Jute)		Bihar (Maize)		Maharashtra (Sugarcane)		Madhya Pradesh (Soybean)	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Main product yield (quintal)	8.86	8.60*** (3.02)	25.25	23.38** (7.99)	539	513 *** (5.06)	5.32	3.86*** (37.82)
2	By-product Yield (quintal)	3.10	3.10NS (0.00)	16.32	16.31Ns (0.06)	0.8	0.8 Ns (0.00)	7.98	7.18* (11.14)
3	Price of main product (Rs/ quintal)	2044	2055Ns (-0.53)	1049	1076Ns (-2.50)	221	216 ** (2.31)	3151	3595** (-12.35)
4	Price of by-product (Rs/ quintal)	250	250Ns (0.00)	152	145Ns (4.82)	415	356 Ns (16.57)	179	163** (9.81)
5	Value of main product (Rs)	18110	17673** (2.47)	26487	25157** (5.28)	119231	110912** (7.50)	16763	13877*** (20.80)
6	Value of by-product (Rs)	775	775NS (0.00)	2481	2365* (4.90)	343	297 NS (15.48)	1428	1170*** (22.05)

Note: ***, ** & * indicate 1, 5 and 10 per cent level of Significance respectively;

Figures in parentheses indicate the percentage change

6.2. Impact of NCU on the cost of cultivation of (reference) crops

6.2.1. Impact of NCU on the cost of cultivation of Paddy

The details of the impact of NCU on the input costs of reference crops across the sample states are presented in **Tables 6.2.1, 6.2.2 and 6.2.3**. To assess the impact of NCU usage on input costs, parameters such as the cost of pest and disease control, the cost of weed management, the cost of NCU or NU, and the cost of other fertilizers were considered. **Table 6.2.1** gives a comparative picture of the input costs of NCU and NU using paddy-farmers. A perusal of the table reveals that, at the aggregate level, the total cost of the selected inputs shows an increase for the users of NCU (Rs.8107/acre) as compared to NU users (Rs.7759/ acre) to an extent of 4.48 per cent, while the cost shows a decreasing trend in respect of all the parameters, excepting the cost of other fertilizers. The decrease in cost of pest and diseases control, weed management, NCU/ NU works out to 6.26, 5.32 and 0.19 per cent, respectively, mainly due to the adoption of NCU in place of NU. Interestingly, all these figures are found statistically significant at about 10 per cent level. Further these results are in conformity with the secondary data published by the DES, 2014-15.

Across states, the results are comparatively the same for the cost of pest and disease control and the cost of weed management. With the proportion of decrease varying from almost three per cent to 13.50 per cent in the case of cost of pest and disease control and from zero to 20.19 in respect of weed management cost. However, with regard to the cost of NCU/ NU and of other fertilizers, the results show a different picture across states in that the cost of NCU/ NU has decreased in the case of Assam (17.59%) followed by Karnataka (3.53%) and Bihar (2.04%), whereas, the cost seems to have increased in Punjab (13.80%), followed by Madhya Pradesh (6.32%) post the application of NCU in place of NU. Similarly, the cost of other fertilizers has decreased with reference to Assam (15.66%), followed by Madhya Pradesh (11.37%), while on the other side, the cost of other fertilizers has increased in respect of Bihar (19.96%) followed by Karnataka (17.45%) and Punjab (3.82%) because of the usage of NCU instead of NU. Overall, the total cost shows an increase to an extent of 16.59 per cent in the case of Bihar followed by Karnataka (7.92%), while, a decreased in respect of Assam (10.36%), Madhya Pradesh (9.97%) and Punjab (4.17%) in the order of magnitude.

Table 6.2.1: Impact of NCU use on the component-wise cost of paddy

(Values in Rs/Acre)

Sl. No.	Particulars	Karnataka		Assam		Bihar		Madhya Pradesh		Punjab		All India	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Cost of pest and disease control	4346	4512* (-3.68)	222	244*** (-9.01)	398	421Ns (-5.46)	324	334** (-2.99)	1518	1755* (-13.50)	1362	1453** (-6.26)
2	Cost of weed management	491	509** (-3.53)	1312	1350Ns (-2.81)	328	411* (-20.19)	301	301NS (0.00)	411	435Ns (-5.51)	569	601*** (-5.32)
3	Cost of NCU / Normal Urea	627	650NS (-3.53)	356	432*** (-17.59)	574	586** (-2.04)	252	237* (6.32)	742	652* (13.80)	510	511*** (-0.19)
4	Cost of other fertilizers	8080	6879*** (17.45)	1179	1398** (-15.66)	12608	10510* (19.96)	5786	6529*** (-11.37)	678	653Ns (3.82)	5666	5194* (9.08)
Total Cost		**13544**	**12550** (7.92)**	**3069**	**3424** (-10.36)***	**13908**	**11928** (16.59)**	**6663**	**7401** (-9.97)**	**3349**	**3495Ns (-4.17)**	**8107**	**7759** (4.48)***

Note: ***, ** & * indicate 1, 5 and 10 per cent level of Significance, respectively;
Figures in parentheses indicate the percentage change

6.2.2. Impact of NCU on the cost of tur cultivation

The economic impact of NCU usage on the cost of cultivation of tur among the NCU and NU users is presented in **Table 6.2.2**. A perusal of the table reveals that, the total cost of selected inputs has increased significantly (75%) among the users of NCU as compared to the users of NU, at the aggregate level. This enormous increase observed in the total cost is the result of an increase in the cost of all other variables such as the cost of pest and disease control (6.65%), cost of weed management (40.24%), cost of NCU/ NU (19.74%) and cost of other fertilizers (67.72%) with respect to the users of NCU in place of NU. This increase in the cost of the other components parameters might be due to the lack of awareness on the part of farmers regarding NCU usage and its associated benefits vis-a-vis NU.

Similar is the situation observed across tur/ redgram growing sample states selected for the study, in that the total cost shows an increase to 131.47 per cent in the case of Karnataka as compared to Maharashtra (20.13%). Although the reference period happened to be a drought phase in Karnataka, the component-wise cost show an increase to an extent of 74.32, 39.20 and 30.98 per cent with respect to other fertilizers, weed management and NCU/ NU, respectively, for farmers using NCU in place of NU. The cost is found to have decreased only in the case of pest and disease control in Karnataka (0.16%), whereas, in Maharashtra, an increase in the cost is noticed in respect of all the components among the users of NCU in place of NU. The increase in cost accounts for 16.68, 54.54, 10.31 and 23.61 per cent for the users of NCU vis-a-vis NU, with respect to pest and disease control, weed management, NCU/NU and other fertilizers, respectively. Notably, almost all the paired sample t -test results relating to Maharashtra seem to be statistically significant, excepting the cost of weed management and vice versa, in the case of Karnataka.

Table 6.2.2: Impact of NCU use on the component-wise cost of tur/ redgram

(Values in Rs./Acre)

Sl. No.	Particulars	Karnataka		Maharashtra		All India	
		NCU	NU	NCU	NU	NCU	NU
1.	Cost of pest and disease control	1208	1210 Ns (-0.16)	972	833 *** (16.68)	1090	1022*** (6.65)
2.	Cost of weed management	838	602** (39.20)	68	44 Ns (54.54)	453	323*** (40.24)
3.	Cost of NCU/ Cost of Normal Urea	279	213 NS (30.98)	278	252 *** (10.31)	279	233Ns (19.74)
4.	Cost of other fertilizers	2661	1297NS (74.32)	1,361	1101 ** (23.61)	2011	1199Ns (67.72)
Total cost		**4986**	**2154NS (131.47)**	**2679**	**2230*** (20.13)**	**3833**	**2192*** (74.86)**

Note: ***, ** & * indicate 1, 5 and 10 per cent level of Significance, respectively;
Figures in parentheses indicate the percentage change

6.2.3. Impact of NCU use on the cost of cultivation of jute, maize, sugarcane and soybean crops

The details of impact of NCU on the input costs of jute, maize, sugarcane and soybean crops across sample states are presented in **Table 6.2.3**. The crop-wise results are discussed in detail in the following paragraphs:

With regard to jute crop in Assam, the aggregate total cost seems to have declined to an extent of 1.93 per cent with respect to the users of NCU in place of NU. This decrease in the total cost is the result of a cumulative decrease in the component cost of weed management (0.08%), NCU/NU (16.78%) and other fertilizers (0.74%) for the users of NCU in place of NU. However, these NCU users have incurred expenditure to the tune of 3.25 per cent due to the application of NCU. From among these components, the cost of pest and disease control and the cost of NCU/ NU are found statistically significant and the rest are found non-significant, whereas, in the case of maize-farmers from Bihar, the total cost appears to have increased to the tune of 14.30 per cent for the adopters of NCU as compared to NU users. However, they have experienced a decrease in the cost of pest and disease control to a significant extent (22.09%) followed by the cost of weed management (3.61%). On the other hand, they are found to have spent more on NCU/ NU and other fertilizers to the extent of 5.08 and 16.66 per cent, respectively. The paired t-test results signify that the cost of NCU/NU, and other fertilizers and the total cost are statistically significant in the case of maize.

Similarly, in the case of sugarcane-farmers in Maharashtra, the extent of increase in the total cost of cultivation is very insignificant (1.24%) for farmers applying NCU in comparison to the users of NU. Excepting the cost of NCU/NU (-15.34%), all other component costs are found to have increased in the case of sugarcane for the users of NCU in place of NU. The increase in the cost is as high as 22.49 per cent in the case of pest and disease control, followed by other fertilizers (4.83%) and weed management (0.49%) because of the NCU application. The paired t-test results found significant in the case of NCU/NU and other fertilizers in respect of sugarcane-farmers and as a result thereby, the total cost is also significant.

Excepting the cost of other fertilizers, the cost of all other selected components found to have declined, in the case of soybean crop, for users of NCU, vis-a-vis users of NU. The highest decrease in cost is noticed in the case of pest and disease control (15.66%) followed by weed management (8.84%) and NCU/NU (3.50%) in the case of soybean-farmers of Madhya Pradesh and also is found statistically significant. The increase in the cost of other fertilizers is very insignificant (0.49%) for the users of NCU in respect of soybean as compared to users of NU. Consequently, the total cost of soybean shows a reduction to the tune of 6.43 per cent for the adopters of NCU in place of NU, and is found statistically significant.

Table 6.2.3: Impact of NCU on input costs of jute, maize, sugarcane and soybean crops

(Values in Rs/Acre)

Sl. No.	Particulars	Assam (Jute)		Bihar (Maize)		Maharashtra (Sugarcane)		Madhya Pradesh (Soybean)	
		NCU	NU	NCU	NU	NCU	NU	NCU	NU
1	Cost of pest and disease control	127	123** (3.25)	268	344Ns (-22.09)	501	409 Ns (22.49)	689	817** (-15.66)
2	Cost of weed management	1211	1212Ns (-0.08)	213	221Ns (-3.61)	607	604 NS (0.49)	443	486* (-8.84)
3	Cost of NCU/ NU	243	292*** (-16.78)	848	807** (5.08)	1451	1714 *** (-15.34)	110	114*** (-3.50)
4	Cost of other fertilizers	1201	1210Ns (-0.74)	11794	10109* (16.66)	5900	5628 *** (4.83)	1215	1209NS (0.49)
Total cost		**2782**	**2837** (-1.93)**	**13123**	**11481** (14.30)**	**8459**	**8355 ** (1.24)**	**2457**	**2626*** (-6.43)**

Note: : ***, ** & * indicate 1, 5 and 10 per cent level of Significance, respectively;

Figures in parentheses indicate the percentage change

6.3. Economic feasibility of NCU using a partial budgeting framework

6.3.1. Economic feasibility of NCU with respect to an overall paddy (partial budgeting framework)

An economic feasibility analysis of NCU use often with and without NCU approach has been used for identifying and assessing, the costs and benefits as part of an evaluation of the current situation more meaningfully. The difference between the costs and benefits is the net incremental benefit arising from the NCU usage. However, before and after approach is not used in this framework on account of changes in production that would have occurred due to regular developments along with the NCU usage. While assessing the benefits and costs of NCU usage only incremental net benefits need to be considered with the reduced benefits treated as costs. The benefits foregone need to be taken as a cost component of NCU usage. Thereby, only incremental value could be attributed to NCU. Hence a partial budget technique is used for assessing the incremental income based on a small change in farm business post NCU application. In the present study, a partial budgeting framework is estimated for the variables such as additional income, reduced costs, reduced income and additional costs following a small change in NCU use vis-a-vis NU. The budget indicates whether the change has increased/ decreased/ no change in net income due to the adoption of NCU. Also, the partial budget compares both the positive and negative effects of a change due to NCU use in relation to NU, or an incremental income accruing from reference crops.

The impact of NCU, based on a partial budgeting technique, considering added and reduced costs due to NCU application in the case of paddy crop is estimated and presented in **Table 6.3.1**. The state-wise partial budgeting Tables are presented in Appendices IIIa. to IIIe. It can be seen from the table that there is a positive impact of the economic feasibility of NCU use on both the main product and by-products of paddy. The variables considered for estimating a partial budgeting framework in the study include the cost of pest and disease control, cost of weed management, cost of NCU/NU, and the cost of other fertilizers. At the aggregate level, the added costs due to NCU application appear to be as high as Rs.739 per acre in the case of other fertilizers only and are shown on the left side (A) of the partial budget framework, whereas, on the other side (B), a cost reduction due to NCU application is noticed with respect to pest and disease control (Rs.70 per acre), weed management (Rs. 46 per acre), cost of NCU (Rs.37 per acre) and other fertilizers (Rs.73 per acre), which all together total to Rs.227 per acre. It is important to note that, the cost of other fertilizers is repeated on both the sides of the table, in view of its reduction in respect of Madhya Pradesh and Assam states (**Appendices IIIb and IIId**).

Table 6.3.1: Economic feasibility of NCU use for an overall paddy (partial budgeting framework)

(Rs/Acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	-	1	Cost of pest and disease control	70.41
2	Cost of weed management	-	2	Cost of weed management	45.98
3	Cost of NCU		3	Cost of NCU	37.22
4	Cost of other fertilizers	739.33	4	Cost of other fertilizers	73.00
Total added Costs		**739.33**	**Total Reduced cost**		**226.61**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product		1	Main product	2808.81
2	By-product yield		2	By-product yield	133.88
Total of reduced returns		**-**	**Total of added returns**		**2942.69**
Total (A)		**739.33**	**Total (B)**		**3169.64**
B-A		**2430.31**			

Note: Additional return from NCU Rs. 2430.31

An added return per acre amounts to Rs. 2942.69. B:C Ratio= 4.28

It is exceptional to note that, nowhere, reduced returns have been observed in the case of paddy, instead, added returns both in terms of the main product and by-product yields are noticed for the users of NCU vis-a-vis NU users. In total, the added returns due to NCU application in the case of main product amounts to Rs.2,809/acre and in the case of by-products to Rs.134/acre, which together works out to Rs.2,942/acre. Therefore, the added costs due to NCU application and reduced returns for the same reason work out to Rs.739/- per acre (Total (A)), while the reduced cost due to NCU and added return due to be NCU turns out to Rs.3170/- per acre (Total (B)). Finally, the net incremental benefit (Total (B) - Total (A)) amounts to Rs.2,430/ acre in the case of aggregate paddy-farmers across the study area. This is the positive impact of NCU adoption in lieu of NU, in addition to other favourable factors. Using the same information, the benefit-cost ratio has been arrived at 4.28, meaning that, for every one rupee of investment on NCU application, there has been a rise in returns to the extent of Rs.4.28. It can be concluded based on these results that, the application of NCU has had a positive impact in terms of both increased yield and income due to reduced costs for the paddy-farmers.

6.3.2. Economic feasibility of NCU in respect of an overall tur (partial budgeting framework)

The economic feasibility of NCU, using a partial budgeting technique for an overall tur crop, is presented in **Table 6.3.2** and the state-wise Tables are presented in Appendices IVa and IVb. **Table 6.3.2** shows the added costs increased due to the application of NCU in place of NU in respect of almost all the components at the aggregate level in the case of tur crop. From among the added costs, the cost of other fertilizers appears to be highest cost (Rs.812 per acre), followed by weed management (Rs.300 per acre), pest and disease control (Rs.139 per acre) and NCU (Rs.49 per acre). Thus, the total added cost due to NCU use is application amounts to Rs.1300 per acre. On the contrary, the reduced cost observed due to NCU use is very insignificant (Rs.3 per acre) in the case of pest and disease control only, particularly, for Karnataka state (**Appendix IVa.**) and hence, the cost of pest and disease control is repeated on both the sides of the partial budget framework. Similarly, reduced returns are noticed in respect of both the main product and by-product yields for overall tur-farmers applying NCU in place of NU. This is mainly because of severe drought conditions facing the tur growing areas of Karnataka during the reference period and vice-versa in the case of Maharashtra.

Table 6.3.2: Economic feasibility of NCU for an overall tur (partial budgeting framework)

(Rs/Acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	139	1	Cost of pest and disease control	3
2	Cost of weed management	300	2	Cost of weed management	-
3	Cost of NCU	49	3	Cost of NCU	-
4	Cost of other fertilizers	812	4	Cost of other fertilizers	-
Total added Costs		**1300**	**Total Reduced cost**		**3**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	305	1	Main product	15,853
2	By-product yield	16	2	By-product yield	708
Total of reduced returns		**321**	**Total of added returns**		**16558**
Total (A)		**1621**	**Total (B)**		**16561**
B-A		**14940**			

Note: Additional return from NCU Rs14940

An added return per acre amounts to Rs. 16558 and B:C Ratio: 10.21

Accordingly, the reduced return due to NCU application amounts to Rs.1621 per acre and the added returns due to NCU use to Rs.16561 per acre, at the aggregate level. Hence, the net incremental benefit (the difference in additional returns (A-B)) works out to Rs.14,940 per acre

and the benefit-cost ratio at 10.21, meaning that, for every one rupee of investment on NCU application, there has been a return to the extent of Rs.10.21. If, we look at state-wise results, it becomes clear that the BC ratio is as high as 30.81 in the case of Maharashtra (**Appendix IVb**) and negative with regard to Karnataka. It is evident from the results that, the application of NCU had a positive impact in terms of an increased income in the form of reduced costs for farmers applying NCU in place of NU in the case of tur crop.

6.3.3. Economic feasibility of NCU for jute (partial budgeting framework)

The economic feasibility of NCU, based on a partial budgeting technique for jute crop, with regard to Assam is presented in **Table 6.3.3**. It is observed from the table that, there are no added costs and reduced returns (Total A) in the case of jute crop, for the adopters of NCU in place of NU, whereas, higher added returns (Rs.616 per acre and a very meagre reduction in costs (Rs.62 per acre) are observed on the other hand (Total B) based on the partial budget framework. Interestingly, the cost of weed management and the cost of NCU seem to be the same, as NU users have noticed from among jute-farmers. The difference between Total B and Total A represents the net incremental benefit, which works out to Rs.615 per acre for the users of NCU in place of NU. Since, the Total of A is zero, the BC ratio was not calculated for jute crop in respect of the study area.

Table 6.3.3: Economic feasibility of NCU for jute (partial budgeting framework)

(Rs/Acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	-	1	Cost of pest and disease control	4
2	Cost of weed management	-	2	Cost of weed management	-
3	Cost of NCU	-	3	Cost of NCU	49
4	Cost of other fertilizers	-	4	Cost of other fertilizers	9
Total added Costs		**0**	**Total Reduced cost**		**62**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	-	1	Main product quintal	531
2	By-product yield	-	2	By-product yield quintal	23
Total of reduced returns		**-**	**Total of added returns**		**554**
Total (A)		**0**	**Total (B)**		**616**
B-A		**615**			

Note: Additional return from NCU is about Rs. 615

An added return per acre amounts to Rs: 554, B:C Ratio= B/A

6.3.4. Economic feasibility of NCU for maize (partial budgeting framework)

The economic feasibility of NCU, based on a partial budgeting technique, for maize crop for the state of Bihar is presented in **Table 6.3.4**. It can be seen from the table that, the added cost, due to NCU application, amounts to Rs. 1686 per acre, mainly due to a higher cost of other fertilizers. On the other side, a reduced cost is observed in respect of pest and disease control (Rs.76 per acre), followed by weed management (Rs.7 per acre). Thus, the total reduced cost due to NCU application amounts to Rs.84 per acre. As expected, there are no reduced returns noticed in the case of maize, instead, added returns are observed in the form of both the main product and by-product yields for users of NCU. Accordingly, the added returns work out to Rs. 1,965 per acre. Therefore, the added costs and reduced returns, due to NCU use add up to Rs. 1686 per acre (Total A) as compared to reduced costs and added returns (Rs. 2049 per acre) on the B side (Total B). Hence, the net incremental benefit works out to Rs.362 per acre in the case of maize crop for Bihar, with the use of NCU in lieu of NU. Similarly, the benefit-cost ratio works out to 1.21, meaning that for every one rupee of investment on NCU application, there has been a rise in returns to the extent of Rs. 1.21. It is evident from the results that, the application of NCU had a positive impact in the case of maize both in the form of an increased income and reduced costs.

Table 6.3.4: Economic feasibility of NCU for maize (partial budgeting framework)

(Rs/Acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	-	1	Cost of pest and disease control	76.44
2	Cost of weed management	-	2	Cost of weed management	7.23
3	Cost of NCU	-	3	Cost of NCU	-
4	Cost of other fertilizers	1685.87	4	Cost of other fertilizers	-
Total added Costs		**1685.87**	**Total Reduced cost**		**83.67**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	-	1	Main product quintal	1963.31
2	By-product yield	-	2	By-product yield quintal	1.52
Total of reduced returns		**-**	**Total of added returns**		**1964.83**
Total (A)		**1685.87**	**Total (B)**		**2048.50**
B-A:		**362.63**			

Note: Additional return from NCU Rs362.63;

An added return per acre amounts to Rs. 1964.83. Benefit Cost Ratio B:C Ratio:1.21

6.3.5. Economic feasibility of NCU use for sugarcane (partial budgeting framework)

The economic feasibility of NCU use, based on a partial budgeting technique, for sugarcane crop in respect of Maharashtra is presented in **Table 6.3.5**. It is found that, excepting the cost of NCU the cost of all other selected components appears to have increased due to NCU application, and hence, the added cost amounts to Rs.585 per acre on the credit side. The cost of NCU shows a reduction to an extent of Rs. 149 per acre, and accordingly the reduced cost amounts to Rs. 149 per acre. In addition, there are no reduced returns observed in the case of sugarcane, as a replacement, the added returns to the tune of Rs. 5749 per acre are noticed due to the application of NCU in place of NU. Thus, the total added cost and reduced returns (Total A) amount to Rs.585 per acre and the reduced cost and added returns (Total B) to Rs. 5898 per acre due to NCU application. Thus, the net incremental benefit (total B-Total A) comes to Rs.5,313 per acre and the benefit-cost ratio to 10.11, meaning that, for every one rupee of investment on NCU application, there has been a rise in returns to the extent of Rs. 10.11 in the case of sugarcane crop.

Table 6.3.5: Economic feasibility of NCU for sugarcane (partial budgeting framework)

(Rs/Acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	92	1	Cost of pest and disease control	-
2	Cost of weed management	3	2	Cost of weed management	-
3	Cost of NCU	-	3	Cost of NCU	149
4	Cost of other fertilizers	272	4	Cost of other fertilizers	-
5	Cost of Micro-nutrients	218	5	Cost of Micro-nutrients	-
Total added Costs		**585**	**Total Reduced cost**		**149**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	-	1	Main product	5,749
2	By-product yield	-	2	By-product	-
Total of reduced returns		**-**	**Total of added returns**		**5,749**
Total (A)		**585**	**Total (B)**		**5,898**
B-A		**5313**			

Note: Additional return from NCU is about Rs. 5,313

An added return per acre amounts to Rs. 5749/ Benefit Cost Ratio BCR: 10.11

6.3.6. Economic feasibility of NCU for soybean (partial budgeting framework)

The economic feasibility of NCU use, based on a partial budgeting technique, for soybean crop in the case of Madhya Pradesh is presented in **Table 6.3.6**. Like, all other crops, there has been a positive impact of NCU noticed with regard to soybean crop, both in terms of the main product and by-product yields. Although there seem to be an added cost due to NCU application, the added returns both in terms of the main product and by-product have taken care of these costs with better return to the soybean-farmers. From among the selected indictors, the highest share of added cost is observed with respect to weed management (Rs. 989 per acre), while the other costs amounts to less than Rs. 63 per acre each. Accordingly, the total added cost works out to Rs. 1141 per acre. Interestingly, on the other side, a negligible reduced cost (Rs.16/ acre) is noticed in the cost of other fertilizers only. Thus, the total reduced cost (due to NCU application) amounts to Rs.16 per acre. As usual, there are no reduced returns noticed with regard to soybean crop for Madhya Pradesh, rather added returns in the form of main product are observed to the tune of Rs. 3942 per acre. Accordingly, the net incremental benefit amounts to Rs. 2817 per acre in the presence of NCU (in lieu of NU) and the benefit-cost ratio to 3.46.

Table 6.3.6: Economic feasibility of NCU for soybean (partial budgeting framework)

(Rs/Acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	43	1	Cost of pest and disease control	
2	Cost of weed management	982	2	Cost of weed management	
3	Cost of NCU	54	3	Cost of NCU	
4	Cost of other fertilizers	62	4	Cost of other fertilizers	16
Total added Costs		**1141**	**Total Reduced cost**		**16**
Sl. No.	Reduced return due to NCU	Costs (Rs.)	Sl. No.	Added returns due to NCU	Returns (Rs.)
1	Main product		1	Main product	3942
2	By-product yield		2	By-product yield	-
Total of reduced returns		**-**	**Total of added returns**		**3942**
Total (A)		**1141**	**Total (B)**		**3958**
B-A		**2817**			

Note: Additional return from NCU Rs. 2817

An added return per acre amounts to Rs. 3942; Benefit Cost Ratio B:C Ratio= 3.46

6.4. Comparative, qualitative and relative benefits of NCU usage vis-à-vis NU

6.4.1. Comparative Benefits of NCU over NU with reference to paddy, tur and jute crops

The comparative benefits of NCU over NU in the case of paddy, tur and jute crops are shown in **Table 6.4.1.1**. It can be seen from the table that about 42 per cent of paddy-farmers, 40 per cent of tur-farmers, and 63 per cent of jute-farmers have found an increase in the yield level to an extent of six per cent, 21 per cent and three per cent, respectively, due to the application of NCU in place of NU. However, a majority of paddy-farmers (47%) and tur-farmers (51%) have experienced no change in yield levels after the application of NCU. About 10-12 per cent of paddy and tur farmers also, have stated that there is a decrease in yield levels after NCU application, however, the extent of decrease is less than the increase in yield levels.

Similarly, a majority of paddy (63%) and tur (85%) farmers and 28 per cent of jute farmers have stated that there is no change in the cost of pest and disease control; conversely, a majority of jute farmers (54%), and about 34 per cent and 13 per cent of paddy and tur farmers reported decrease in the cost of pest and disease control to the tune of 20, 15 and 11 per cent, respectively, whereas, as per a negligible proportion of farmers in respect of each crop, there is an increase in the cost by two to nine per cent. In respect of all the reference crops such as paddy, tur and jute, according to more than 75% of the farmers there is no change in weed management cost. However, about 25 per cent of jute farmers, nine per cent of paddy and two per cent of tur farmers have experienced an increase in the cost of weed management by two to four per cent.

In a similar way, there is a difference of opinion among farmers with respect to the cost of NCU as compared to NU and the cost of other fertilizers. According to tur farmers (>55%), there is no change in the cost of both NCU and NU, while as per more than 95 per cent of jute farmers there is decline in the cost of both. However, in the case of paddy farmers, a majority (74%) of the farmers experienced no change in the cost of other fertilizers, but, there is an increase in the cost of NCU, as revealed by 46 per cent of the farmers. With regard to improvement in soil health, quality of grains and market acceptability, according to almost cent per cent of jute farmers, and more than 82 per cent of paddy farmers there is no change in these characteristics post NCU application. On the other hand, more than 52 per cent of the tur-farmers have witnessed an increase in terms of an improvement in soil health and quality of grain and the resultant market acceptability of grains.

Table 6.4.1.1: Comparative Benefits of NCU application over NU in respect of paddy, tur and jute crops

Sl. No.	Particulars	Paddy					Tur					Jute				
		Inc	Dec	No change	Ext of inc (%)	Ext of Dec (%)	Inc	Dec	No change	Ext of inc (%)	Ext of Dec (%)	Inc	Dec	No change	Ext of inc (%)	Ext of Dec (%)
1	Yield (quintals)	41.67	11.94	46.47	6.09	3.09	39.53	10.21	50.74	20.84	11.33	63.03	-	36.97	2.99	-
2	Cost of pest and disease control (Rs)	2.81	34.36	62.82	4.90	11.20	1.81	13.22	84.96	1.75	15.47	18.18	53.94	27.88	9.24	20.03
3	Weed management (Rs)	8.61	13.97	77.39	3.83	5.30	2.03	7.37	91.08	3.00	17.04	24.85	-	75.15	4.17	-
4	Cost of NCU compared to NU (Rs)	45.69	22.84	31.58	26.92	11.33	41.28	3.50	55.21	10.41	-	-	100.00	-	-	26.33
5	Cost of other fertilizers (Rs)	10.65	15.66	73.68	2.30	4.77	30.00	2.00	68.50	-	-	5.42	94.58	-	12.43	4.52
6	Improvement in soil health	15.80	2.12	82.07	0.40	-	53.22	0.50	46.28	3.00	-	-	-	100.00	-	-
7	Quality of grain	14.97	-	85.02	-	-	53.92	0.40	45.68	-	-	-	-	100.00	-	-
8	Market acceptability of grain	16.43	0.12	83.43	-	-	51.94	0.81	47.24	-	-	-	-	100.00	-	-

Note: Inc - Increase; Dec – Decrease

6.4.1.2: Comparative Benefits of NCU vis-a-vis NU in the case of sugarcane, maize and soybean crops

The details of comparative benefits of NCU vis-a-vis NU with respect to sugarcane, maize and soybean crops are shown in **Table 6.4.1.2**. It can be seen from the table that, a majority of sugarcane farmers (98%) and a minor proportion of maize (18%) and soybean (4%) have accepted that there is an increase in yield levels by 7 to 10 per cent. On the contrary, a greater proportion of maize (78%) and soybean farmers (96%) have experienced no change in yield levels post application of NCU as against NU. With respect to the cost of pest and disease control and weed management, more than 72 per cent of the farmers in respect of reference crops such as sugarcane, soybean and maize have reported no change. However, about 8 to 28 per cent of the farmers in respect of these crops, have expressed that there is a decline in the cost of pest and disease control and weed management up to thirteen per cent, while a negligible proportion has reported that there is an increase in the cost of these two components.

The cost of NCU as compared to NU has increased in the case of sugarcane and soybean crops, as reported by more than 65 per cent of the farmers each, while the increase is five per cent with respect to paddy and 10 per cent in the case of soybean. About 75 per cent of the farmers have experienced no change in the case of maize, whereas, with regard to the cost of other fertilizers, 62 per cent of paddy and 91 per cent of maize farmers have observed no change. As for other qualitative impacts of NCU, a majority (>61%) of the paddy farmers have witnessed an improvement in soil health, quality of grains and market acceptability. Whereas, in the case of maize, a highest proportion of the farmers (>91%) has witnessed no change in all these variables in the context of NCU and NU application. However, none of the jute farmers has responded to these questions.

6.4.2. Relative benefits of NCU reflected in soil health improvements vis-a-vis NU in the case of paddy, tur and sugarcane crops

Table 6.4.2.1 presents the relative benefits of NCU use in soil health improvements over NU in respect of paddy, tur and sugarcane crops. It is noticed that about 62 per cent of sugarcane and 24 per cent each of paddy and tur farmers have found an improvement in soil health post the application of NCU in comparison to NU. With respect to paddy farmers, more than 70 per cent have observed an improvement in soil texture, soil moisture retention, water infiltration and soil softness, while only 27 per cent of the farmers have found a decrease in soil compaction. In the case of tur crop, a majority of the farmers (>71%) noticed an improvement in terms of soil moisture retention and water infiltration. About 43% have observed an improvement in soil

Table 6.4.1.2: Comparative Benefits of NCU application over NU in respect of sugarcane, maize and soybean

Sl. No.	Particulars	Sugarcane					Maize					Soybean				
		Inc	Dec	No change	Ext of inc (%)	Ext of Dec (%)	Inc	Dec	No change	Ext of inc (%)	Ext of Dec (%)	Inc	Dec	No change	Ext of inc (%)	Ext of Dec (%)
1	Yield (quintals)	98.00	-	2.00	10.00	-	18.00	4.00	78.00	6.89	7.11	3.82	-	96.18	-	-
2	Cost of pest and disease control (Rs)	2.00	16.00	82.00	-	-	0.50	27.50	72.00	7.50	12.71	3.50	2.25	94.25	-	-
3	Weed management (Rs)	2.00	13.00	85.00	-	-	8.00	7.00	85.00	7.52	12.69	-	-	-	-	-
4	Cost of NCU compared to NU (Rs)	69.00	24.00	7.00	5.00	-	25.00	-	75.00	11.52	-	65.00	10.75	24.25	10.00	-
5	Cost of other fertilizers (Rs)	30.00	8.00	62.00	-	-	9.50	-	90.50	8.15	-	-	-	-	-	-
6	Improvement in soil health	88.00	2.00	10.00	-	-	9.00	-	91.00	-	-	-	-	-	-	-
7	Quality of grain	74.00	-	26.00	-	-	3.50	-	96.50	-	-	-	-	-	-	-
8	Market acceptability of grain $	61.00	-	39.00	-	-	5.50	-	94.50	-	-	-	-	-	-	-

Note: Inc - Increase; Dec - Decrease

softness and 37 per cent in soil texture. As in the case of paddy, only 22 per cent have observed a decline in soil compaction. Similarly, as expressed by a greater proportion (56%) of sugarcane farmers there is an improvement in terms of soil texture, followed by soil moisture retention (54%), water infiltration (52%), and soil softness (48%). However, according to about 44 per cent of sugarcane farmers that there is a decrease in soil compaction post NCU application.

Table 6.4.2.1: Relative benefits of NCU application reflected in soil health improvements vis-a-vis NU in respect of paddy, tur and sugarcane crops

(% Farmers)

Sl. No.	Particulars	Paddy	Tur	Sugarcane
Farmers perceptions regarding comparative advantages of NCU application		23.80	24.00	62.00
1	Texture improved	70.50	36.79	55.64
2	Soil moisture retention increased	89.91	71.69	54.03
3	Improvement in water Infiltration	90.75	73.58	51.61
4	Improvement in soil softness	90.75	43.39	48.38
5	Compaction decreased	26.89	21.69	44.34

6.4.2.2: Relative benefits of NCU application reflected in soil health improvements vis-a-vis NU in respect of maize, soybean and jute crops

The relative benefits of NCU usage in soil health improvements over NU in respect of maize, soybean and jute crops are shown in **Table 6.4.2.2**. It is noticed from the table that about 82 per cent of jute-farmers and 44 per cent of maize-farmers have observed an improvement in soil health post NCU application in place of NU. It is understood from the table that almost all the respondents have witnessed improvement in soil health post the usage of NCU in terms of texture, moisture retention capacity, infiltration and softness and a decrease in soil compaction in the case of both maize and jute crops. However, none of the respondents has been able to understand these characteristics, as they are a little technical in nature and whatever views they have expressed regarding these aspects are based on their long farming experience.

Table 6.4.2.2: Relative benefits of NCU usage reflected in soil health improvements vis-a-vis NU in respect of maize, soybean and jute crops

(% Farmers)

Sl. No.	Particulars	Maize	Soybean	Jute
Farmers perceptions regarding the comparative advantages of NCU application		43.50	-	82.00
1	Texture improved	42.00	-	82.00
2	Soil moisture retention increased	31.00	-	82.00
3	Improvement in water Infiltration	34.00	-	82.00
4	Improvement in soil softness	39.50	-	82.00
5	Compaction decreased	38.00	-	50.50

6.4.3. Qualitative benefits of NCU with respect to paddy, tur and sugarcane crops

The qualitative benefits of NCU use with respect to paddy, tur and sugarcane crops are shown in **Table 6.4.3.1**. The qualitative benefits have been assessed based on attributes such as improvement in soil health, quality of grains and their acceptability in the market. It can be noticed from the table that, there has been an improvement in soil health, quality of cane, and their market acceptability of grain colour post adoption of NCU in place of NU, as reported by 88 per cent, 74 per cent, and 61 per cent of sugarcane farmers, respectively. Similarly, more than half of the tur sample farmers (>52%), have observed an improvement in soil health, quality of tur grain and market acceptability of its colour post adoption of NCU as compared to NU. The rest have not witnessed any change in respect of these attributes. However, with respect to paddy, a large number of farmers (87%) have noticed an improvement in terms of soil health and quality of grain, while about 59 per cent have reported a decline in the market acceptability of grain colour. Further, about 13 per cent of paddy farmers have perceived an improvement in soil health and quality of grains produced, and as per the opinion of about 29 per cent the market acceptability of grain colour has improved post NCU application.

Table 6.4.3.1: Qualitative benefits of NCU observed with respect to paddy, tur and sugarcane crops

(% Farmers)

Sl. No.	Particulars	Paddy			Tur			Sugarcane		
		Inc	Dec	No change	Inc	Dec	No change	Inc	Dec	No change
1	Improvement in Soil health	13.30	00.10	86.60	53.22	00.50	46.28	88.00	02.00	10.00
2	Quality of grain	13.20	-	86.80	53.92	00.40	45.68	74.00	-	26.00
3	Market acceptability of grain colour	28.80	59.00	12.20	51.94	00.81	47.25	61.00	-	39.00

Note: Inc - Increase; Dec - Decrease

6.4.3.2: Qualitative benefits of NCU observed with respect to maize, soybean and jute crops

The qualitative benefits of NCU use with respect to maize, soybean and jute crops are shown in **Table 6.4.3.2**. Similar to other crops, the qualitative benefits have been assessed based on attributes such as an improvement in soil health, quality of grains and their acceptability in the market. It can be noticed from the table that, there has been an improvement in soil health, quality of grains, and their market acceptability post the adoption of NCU in place of NU, as reported by 82 per cent, 50 per cent, and 82 per cent of jute farmers, respectively. However a majority of maize and soybean (>91% each) farmers noticed no change in these attributes, while a smaller proportion of maize farmers has accepted that there is a change in terms of improvement in soil health, quality of maize grains and its colour.

Table 6.4.3.2: Qualitative benefits of NCU observed with respect to maize, soybean and jute crops

(% Farmers)

Sl. No.	Particulars	Paddy			Tur			Sugarcane		
		Inc	Dec	No change	Inc	Dec	No change	Inc	Dec	No change
1	Improvement in Soil health	9.00	-	91.00	-	-	100.00	82.00	-	18.00
2	Quality of grain	3.50	-	96.50	-	-	100.00	50.00	-	50.00
3	Market acceptability of grain colour	5.50	-	94.50	-	-	100.00	82.00	-	18.00

Note: Inc - Increase; Dec - Decrease

6.5. Chapter Summary

Based on the results, it appears that NCU has created a positive impression among the sample farmers as for as production and marketing of reference crops is concerned by way of facilitating increased outputs and returns and reduced cost of cultivation. The increase in output of both the main product and by-products might not be directly related to the use of NCU only, as other favourable factors might have contributed to the same. Although a majority of the farmers are not aware of the potential benefits of NCU use vis-a-vis NU. What should be a matter for concern is that they blindly started applying NCU because of the mandatory production of NCU across the country and the traditional knowledge on the benefits of neem use in the cultivation of agricultural crops. It is important to note here that studying a single season (the study period) may not be a sufficient condition by itself in understanding the actual benefits of NCU use and hence, it may require some more time before assessing the actual impact of NCU usage on crops.

Across the reference crops, the increase in the main product yield is as high as 38 per cent in the case of soybean farmers, followed by 34 per cent in respect of tur/ redgram (particularly in Maharashtra), nine per cent in the case of jute, eight per cent each in the case of paddy and maize and five per cent with regard to sugarcane, whereas, when it comes to by-products, not much difference is observed, excepting tur/ redgram crop in Karnataka (23%) and paddy (3%). In most of the cases, prices show a declining trend for the reference period due to market imperfections. As regards the cost of cultivation, there is an increase observed in the total cost in the case of paddy, tur, maize and sugarcane farmers, however, a highest increase in the total cost (75%) is noticed with respect to tur/ redgram. From among the selected costs, the cost on other fertilizers accounts for a major share in respect of almost all the crops, excepting sugarcane. The other costs such as the cost of pest and disease control, cost of weed management and the cost of NCU show a decreasing trend at the aggregate level, may be because of neem coating.

The partial budget framework has tried to address the issue of incremental income in the presence of NCU in the study. It's found that, despite the added costs noticed across the reference crops, the incremental income shows a positive impact in terms of increased levels of output with respect to both the main product and by-products at the aggregate. The benefit-cost ratio also indicates that the return per rupee investment on NCU is positive i.e., as high as 10.21 in the case of tur/ redgram, followed by sugarcane (10.11), paddy (4.28), soybean (3.46) and maize (1.21).

As regards the comparative and qualitative benefits of NCU, a majority of sample farmers have observed an improvement in yield, soil health, quality of grain and market acceptability of grain, however, with respect to weed management and pest and disease control, a majority farmers shown a mixed response. A large portion of the respondents are is satisfied with the relative benefits of NCU in terms of an improvement in soil health characteristics such as soil moisture retention and water infiltration. As for the perceptions of farmers regarding NCU, more than half of the sample farmers are satisfied with the quality, adequacy and timely availability of NCU and its further improvement post mandatory production and distribution as compared to NU. However they feel that the NCU price has slightly increased.

Professor seeing NCU on hand to distinguish it from NU

Field Investigators interacting with the Agriculture Officers

7. Summary, Conclusions and Policy Suggestions

7.1. Background

Urea is one of the most widely used sources of nitrogen fertilizers in India. It has high nitrogen content (46%) relative to many other popular nitrogen fertilizers. When urea is applied to soil, it gets transformed to ammonical (NH4+) form first, and post its hydrolysis, it gets converted into nitrite (NO2-) and then into nitrate (NO3-) through the nitrification process. Most of the crop plants use nitrate as a source of nitrogen, excepting rice which prefers ammonical form to nitrate. Although nitrification is a necessary phenomenon for making nitrogen available to crops, a rapid nitrification is one of the key processes encouraging nitrogen losses from the soil. Also, nitrogen in nitrate form is highly volatile and gets lost through the process of leaching, especially under irrigated conditions. Nitrogen Use Efficiency (NUE) is found below 33 per cent at the global level, while the unaccounted 67 per cent escapes through different routes during the process of de-nitrification, and may contribute to the contamination of water bodies and the atmosphere. Moreover most of the subsidized urea supplied is diverted to industrial use, creating scarcity during the sowing season in the process.

In this respect, there exists a wide range of empirical literature dealing with the demerits of urea, its adverse environmental impact through excessive nitrogen losses, and the need for the development of new methods for improving NUE in crops. Neem has proved to be a significantly superior material vis-a-vis other coating agents in terms of many agronomic traits such as growth, yield attributes, grain and straw yields, nitrogen uptake and apparent Nitrogen (N) recovery.

As the synthetic fertilizer usage, became increasingly widespread its impact became adverse even as the scientists began directing their research towards finding out natural and eco-friendly chemicals. In this regard, neem based pesticides or chemicals are found to be much safer as they have no ill-effects on humans and animals or residual effects on agricultural produce. Realizing the various benefits associated with neem coating and its positive impact on environment, National Fertilizer Limited (NFL) developed a process for production of Neem Coated Urea (NCU) on a commercial scale in 2002. Later, recognizing the potential of NCU and its acceptance by farmers, Ministry of Agriculture, Government of India, included NCU in Fertilizer Control Order (FCO) since July 2004. Thus, NFL became the first company in India to have been permitted to produce and market NCU. This was mentioned in the Government of India Notification No S.O.807 (E) dated 9 July 2004. In the initial years, the total production of NCU was limited up to 35 per cent. Later, from March 2015, the Department of Fertilizer (DOF) made it mandatory

for all domestic producers of urea to produce 75 per cent of their production with neem coating and from 25th May, 2015, the cap was increased to 100 per cent.

An intensive cropping practice with an unscientific application of fertilizers has led to deterioration in soil health in the recent years, resulting in a sub-optimal use of resources, a cause for concern. On the other hand, a low addition of organic matters has led to an imbalanced use of fertilizers and non-replacement of depleted nutrients to nutrient deficiencies and a resultant decrease in soil fertility. In this context, both the state and central governments have tried to implement various schemes and programmes with respect to soil health as part of creating awareness among the farming community regarding the importance of soil health and its management based on soil test technology.

A recent programme, Soil Health Card Scheme (SHCS), launched on 19th February, 2015, by the Government of India, aims at improving the yield levels of crops through a judicious use of fertilizers. Under the scheme, soil health cards (SHCs) are issued to individual farmers containing crop-wise recommendations of nutrients and fertilizers required for plant growth. In this respect the Department of Fertilizers (DoF) and its own Integrated Nutrient Management (INM) division of the Ministry of Agriculture and Farmers Welfare entrusted a study to Agricultural Development and Rural Transformation Centre (ADRTC) of the Institute for Social and Economic Change (ISEC), Bengaluru, to assess the impact of NCU use on production, productivity and soil health and to document the status and implementation of SHC scheme with a view to improving the efficiency of these significant initiatives. It is to be noted that both these initiatives of the central government mandatory production and distribution of NCU and Soil Health Card Scheme are aimed at improving productivity and soil health through a prudent use of fertilizers.

The specific objectives of the study are as under:

1 To study the trends in usage and prices of Urea and NCU.
2 To analyse the adoption behaviour of NCU farmers in irrigated and rainfed conditions.
3 To analyse the impact of NCU on yield and income.
4 To document the status and implementation of soil health card scheme.

The present study relied on both the primary and secondary data collected from the selected States in India. The reference period for the study is Kharif 2015. One crop each consuming highest urea from irrigated and rain-fed tracts from each of the selected states was considered for the study. Accordingly, the selected crops under the study included paddy, sugarcane, jute, maize, tur and soybean. For each crop, two districts were selected based on the area under selected crop, and their urea usage within the state. From each district, two taluks/ tehsils were selected based on the same criterion. From within the selected taluks, two clusters of villages comprising 3-4 villages per cluster were selected for conducting the survey. A sample

of 50 farmers from each taluk was selected adding up to 100 farmers from their each district. Households were selected randomly for assessing the use of NCU fertilizers and their impact on crop production. The post-classification of the households included two categories NCU users and non-users (those using Normal Urea) mainly to explore the impact of NCU relative to NU. Further, an adequate care was taken to ensure that the selected crops were grown under chosen irrigated/un-irrigated conditions in the state. Thus, a total of 200 (NCU/ normal Urea) farmers for each crop were interviewed using a pretested structured questionnaire. Beside, an adequate care was taken in the selection of the representative sample based on the operational land holding size. The information gathered was analysed using tabular method, CAGR, Exponential functions, partial budgeting framework and paired unequal sample 't' test for deriving meaningful inferences.

7.2. Summary of Findings

7.2.1. Trends in urea consumption and price variations

Urea accounts for 57 per cent of the total fertilizer consumption in India (2014-15), with a growth rate of more than two per cent annually for the period 2006-07 to 2015-16. The consumption of urea has been increasing more than its domestic production, forcing the government to raise its urea imports, at a significant growth rate of six per cent per annum including the reference period. The increased urea consumption has led to an imbalanced application of nutrients. Keeping this aspect in view, the government brought urea under controlled fertilizers, while decontrolling phosphatic and potassic fertilizers. To provide support to the domestic manufacturers, the New Pricing Scheme for Urea units, and the concession Scheme for decontrolled Phosphatic and Potassic fertilizers were introduced. Subsequently, the price of urea per bag increased marginally from Rs 262.50 in 2006-07 to Rs 268 in 2015-16, at the aggregate level.

From among the selected states, the highest percentage of urea consumption is found registered in respect of Punjab (between 23 to 27%), followed by Maharashtra (20 to 25%), Bihar (16-19%), Karnataka (13%) and Assam (3%) for the entire study period (2006-07 to 2015-16). The rising prices of DAP and MOP as compared to urea are considered one of the main reasons for an imbalanced usage of NPK fertilizers. The growth rate of urea prices over the period 1980-81 to 2015-16 indicates that, the highest decadal growth rate of urea prices increased significantly at a five per cent per annum for the period 1990-91 to 1999-2000. For the rest of the years, the increase in the growth rate of urea prices has been less than one per cent per annum.

7.2.2. Socio-economic characteristics of the sample households

A majority of the sample farmers are males in the study area with an average family size of seven members, of which three being engaged in farming. They have an experience of 24 years in the farming, but a majority of them have studied up to below Pre-University level. More than

half of the respondents are belong to the general category, followed by Other Backward Classes (OBCs) (29%) and Scheduled Castes and Tribes.

The average net operational area in the study region is comparatively more in the case of sugarcane farmers, followed by paddy and tur farmers. As usual, the highest operational land holding lies with the large farmers in respect of all reference crops. It is very important to note that, a majority of the farmers undertake crop cultivation depending upon the irrigation sources, even under rainfed conditions. The higher proportions of irrigated land are found among small farmers, followed by medium and large, as they are not ready to take any risk in the process of crop cultivation. The leased-in land and its rental values are highest in the case of paddy (Rs.15231/ acre), followed by soybean (Rs.13639/ acre) and jute (Rs. 5696/ acre). The common crops grown by the sample farmers include paddy, maize, cotton, basmati, sugarcane, fodder crops, vegetables and other crops such as pulses and oilseeds. Only in the case of maize and jute, the reference crops are given a secondary preference. Interestingly, none of the sugarcane farmers cultivates paddy, maize, jute, soybean and Kharif vegetables, although they have access to irrigation facilities. It is very important to note that, none of the maize, soybean and jute farmers is in taking up the production of cereals in the study area.

It is observed that, a majority of the small and marginal farmers have moved away from agriculture into horticulture, production of commercial crops such as pulses and oilseeds and dairy farming etc., as part of avoiding any risk and generating an additional income. Bore wells form the major source of irrigation (57%) across reference crops, followed by open/ dug wells (32%), while canal irrigation is the third important source of irrigation for paddy, sugarcane and tur farmers. Although tur is a dry land crop, a few farmers irrigate this crop with more than one source. As regards the financing of agriculture, a majority are found to have availed of loans from institutional sources (53%) as against the non-institutional sources from among the sample farmers. It appears to be a good symptom of development. Among the institutional sources, commercial banks followed by cooperatives form the major sources of finance, whereas, among the non-institutional sources, money lenders and traders/ commission agents happened to be the major sources of credit to the sample farmers. At the aggregate level, seasonal crop cultivation (56%) is the main purpose behind borrowing of loans, apart from all other purposes.

7.2.3. Status of awareness and application of Neem Coated Urea

The mandatory production of NCU has been initiated since May, 2015. Although farmers started applying NCU, a majority of them are not aware of the benefits of NCU relative to NU. It is revealed from the study that more than 70 per cent of the farmers growing all reference crops are aware of NCU usage excepting tur/ redgram growing farmers (27 per cent). Because of dryland cultivation of tur/ redgram, a majority of the farmers hardly apply any chemical fertilizer, however, a negligible proportion of the farmers, with access to irrigation are found to

be applying fertilizers. With regard to the sources of information about NCU, the main sources of information are agricultural officers of the State Department of Agriculture (SDA), followed by input suppliers and fellow farmers across all the selected crops in the country. However, in the case of sugarcane, cooperatives also play an important role in spreading awareness regarding the potential of NCU.

Similar to the awareness regarding NCU, except in the case of tur/ redgram, a majority (>77%) of the farmers growing all the reference crops are able to differentiate between NCU and NU, based on the leaf figure on the bag, colour and price-difference. However, more than one factor help sugarcane-farmers differentiate between NCU and NU. Less than 25 per cent of the farmers have undergone training with respect to the application of fertilizers across crops, however, the proportion is nil in the case of jute and maize farmers. Interestingly, the SDA is the major source of trainings on fertilizer application, as expressed by a majority of the farmers who have undergone trainings.

The purchase pattern of NCU and NU fertilizers gives a comparative picture of the usage of NU and NCU fertilizers in respect of all the reference crops. Excepting paddy farmers in Karnataka, Madhya Pradesh and Punjab, and maize-farmers in Bihar, the average quantity of NCU purchased is found higher than NU fertilizers, may be due to their ignorance about the slow releasing property of NCU and its benefits relative to NU. However, the prices of NCU/NU are highest for tur in Karnataka and lowest in Punjab. For both NCU and/or NU, the private fertilizer dealers/ cooperative societies are the major source of purchase across the sample states. Although NCU was available in different states earlier its usage has increased only after Kharif 2015-16, because of mandatory production of NCU in place of NU. A majority of paddy, jute, soybean and maize-farmers apply NCU/NU at the time of vegetative growth followed by post weeding, whereas, in the case of tur/ redgram, NCU/ NU is applied at the basal and maturity stages, however, with regard to sugarcane, it is applied at all the stages of plant growth. Hence, the quantity applied is found more in respect of sugarcane.

The perceptions of farmers regarding NCU usage reveal that the quality of NCU is good, adequate, timely available, accessible in the market and evenly distributed in respect of almost all the crops, excepting tur/ redgram farmers with most of them being unable to notice any difference in terms of its quality and timely availability as compared to NU. On the other hand, a majority of the farmer have expressed that the price is reasonably high, but not very high along with no significant decline in the total fertilizer usage and urea usage across crops. In terms of relative benefits of NCU and NU, a majority of the sample farmers have observed an improvement in the yield levels across all crops due to NCU use. However, a mixed response is noticed in respect of cost the of pest and disease control and weed management from among the respondents. A majority of the farmers also have noticed there is no change in the cost of NCU as well as of other fertilizers due to the application of NCU in place of NU. However it is difficult to observe

all the changes of NCU usage within this short period of time and hence, a similar study can be conducted later, considering this study as a benchmark.

An effort was also made by this study to explore the relative benefits of NCU and NU based on the experience of farmers in farming, through a scientific approach. A large proportion of the respondents, except in the case of soybean has expressed the relative benefits of NCU in terms of an improvement in soil health characteristics such as soil texture, soil moisture retention, water infiltration and soil softness and water infiltration and reduced soil compaction post NCU application. The qualitative benefits were assessed based on attributes such as an improvement in soil health, quality of grains and their acceptability in the market. It is noticed that, excepting maize and soybean crops, there has been an improvement in soil health, quality of cane/grains, and the market acceptability of the grain colour post adoption of NCU in place of NU. However, a few farmers also have observed a decline in the market acceptability of grain colour in the case of paddy.

As regards the input costs and the outcome across reference crops before and after NCU reveals that, there is a slight increase in the total paid-out costs for Kharif 2015 as compared to Kharif 2014. However, these costs are spread across different input costs used in the production process of these reference crops. Although the prices of NCU are slightly higher than NU, the total cost on NU/NCU shows a drastic reduction for Kharif 2015. On the contrary, both the main product and by-product yields have increased across crops and thereby, net returns for Kharif 2015, excepting tur and maize crops.

Our field-based observation reveal that a fair proportion of the farmers uses NU in the preparation of feed for cattle and fishery, by way of mixing a very minute quantity i.e., 0.1gm/kg in milk to enhance fat content, however they have stopped this practice post the introduction of NCU. The study points to the lack of awareness regarding the benefits of NCU and higher prices as the major problems faced by a majority of the farmers across states and reference crops. Hence, they have suggested that there is need for creating awareness and organizing trainings on NCU benefits relative to NU and reducing NCU prices by the Government.

7.2.4. Status of Soil Health Card Scheme Implementation and Adoption of Soil Testing Technology by the Farmers

From the secondary sources, it is understood that, the sample collection has exceeded the target, whereas, in terms of progress made in respect of samples tested, the achievement is 81 per cent and in terms of printing and distribution, the achievement is still less than half of the target set (42% and 51%, respectively). The progress is relatively the same across States. The slow progress made in respect of soil testing might be due to the lack of infrastructure facilities in almost all the States. Although various programmes have been in operation for testing soils

free of cost across states, the farmers who have tested their soil systems account for less than 35 per cent. Unfortunately, none of the maize and jute farmers have tested the soil systems before three years.

A majority of the farmers prefer district laboratories of SDA and KVKs for testing their soil systems in respect of almost all the crops, excepting sugarcane, with a majority of farmers opting for sugar factories. Accordingly, officials of SDA are the key source of information on soil testing across crops, followed by KVKs and farmer facilitators. Interestingly, a majority of the paddy, tur and sugarcane farmers collect the soil samples on their own, while in the case of maize and jute farmers, farmer facilitators help collect the soil samples. With respect to jute, the officials of SDAs help the most. Understanding the fertilizer requirements of crops is treated as the most important reason by a majority of the respondents, followed by motivation gained from village demonstrations/ training/ exposure visits to different places and poor crop yield. On the other hand, 'do not know how to draw soil samples', followed by 'soil testing laboratories are located far away', 'do not know whom to contact for details on soil testing' are the most important reasons for not testing their soil systems.

From among the soil tested farmers (35%), less than half of them have received SHCs through not on time. Out of them, only about 19 per cent of paddy, 14 per cent of tur, 36 per cent of sugarcane, six per cent of maize and 13 per cent of jute farmers are aware of RDFs on the basis of information provided in SHCs. Again a majority of these farmers have received RDFs-related an explanations from the officials of SDA followed by private input dealers. Although they are aware of RDFs with the help of SHCs, a majority of them apply fertilizers on 'recall' method.

No distribution of SHCs on time and lack of information on soil test technology are the major problems reported by the sample farmers. Accordingly, 'ensure access to free and timely SHC distribution', 'establish soil test laboratories at each taluk level', 'organize trainings on soil sampling' are the major suggestions made by the soil tested farmers across the country. In addition, there is a need for creating infrastructural facilities for increasing the soil testing, printing and distribution of SHCs. Further, there is a need to address the issues related to the soil sample collection under a grid system, which include network and visibility issues of GPS devices, manpower requirements etc.

7.2.5. Impact of NCU application on crop production and soil health

To understand the impact of NCU on production, productivity, income and soil health among the users of NCU in place of NU were studied using both quantitative and qualitative information gathered from the sample farmers with regard to six reference crops in the country. It is very interesting to note that, NCU had a positive impact on all the selected variables under the study. As regards the main product across all reference crops, there has been an increase in the yield

levels to an extent of 38 per cent (1.46 quintal/acre) in soybean, 34 per cent (0.90 quintal/acre) in tur/redgram, 8 per cent each (1.62 & 1.87 quintal/acre) in paddy and maize, 5 per cent (26 quintal/acre) in sugarcane and 3 per cent (0.26 quintal/acre) in jute crops, post the application of NCU in place of NU. With respect to by-products of the reference crops, the yield has increased in the case of paddy (3%) (0.82 quintal/ acre), tur/ redgram (23%) (0.45 quintal/ acre) and soybean (11%) (0.80 quintal/acre), while no change has been noticed in respect of jute, maize, and sugarcane crops post NCU application in place of NU. Interestingly, in the case of paddy, the highest yield has been observed in respect of Madhya Pradesh (17%), and the lowest yield is observed for Punjab (1%). Similarly, with respect to tur crop, the highest by-product yield is found for Karnataka as compared to Maharashtra. With an increase in yield levels, the value of the main product and by-products have increased in the case of almost all the reference crops, although the market prices are imperfect at the aggregate level. The decrease in the value of main product in the case of tur crop in Karnataka can be attributed to the severe drought conditions prevailing in tur/ redgram growing areas during the reference period.

To assess the impact of NCU on input costs, components such as the cost of pest and disease control, the cost of weed management, the cost of NCU or NU and the cost of other fertilizers were considered. Overall, it is noticed that there is a mixed response across the reference crops in terms of the total cost of cultivation post NCU application. An increase in the total costs is observed in the case of paddy (4%), tur (75%) and maize (1%) cultivators, while at the same time, a decrease in total cost is observed in respect of jute (2%) and soybean (6%). The substantial increase in total cost of tur/ redgram is due to an increase in the costs of almost all the inputs used in the production process. Across selected cost components, a decrease in the cost of pest and diseases control and weed management is noticed in the case of paddy, jute, maize and soybean reference crops due to the adoption of NCU, whereas, an increase in the cost of these components is observed with respect to tur/ redgram and sugarcane. Out of the parameters considered, a highest increase in cost is noticed in the case of other fertilizers, while a heterogeneous trend is noticed in terms of the cost of NCU/ NU with regard to the reference crops. Regarding paddy crop, a decrease in the total cost is observed in respect of Assam and Madhya Pradesh (10% each) and Punjab (4%).

Impressive results are observed based on a partial budgeting technique in that it reveals that the incremental income accruing due to the application of NCU in place of NU. It is observed that in respect of all the reference crops, no reduced returns are observed, instead, added returns are seen in the form of main product and by-product yields, due to NCU application. The highest incremental income is noticed in the case of tur/ redgram (Rs.14940 per acre), followed by sugarcane (Rs.5313 per acre), soybean (Rs.2817 per acre), paddy (Rs.2430 per acre), jute (Rs.615 per acre) and maize (Rs.363 per acre) crops. Accordingly, the benefit-cost ratio works out to 10.21, 10.11, 4.28, 3.46 and 1.21 with respect to tur, sugarcane, paddy, soybean and

maize respectively, in the order of magnitude due to the application of NCU in lieu of NU. This incremental income may not be directly linked to the usage of NCU alone, as there might be other favourable variables that might have contributed to the same.

7.3. Conclusions

Recognizing the various benefits of NCU and its positive impacts on the environment, the Union Government of India has made mandatory the production of NCU (100%) across the country. The aim of the policy is to control an excess use of urea in agriculture, besides preventing the diversion of subsidized urea towards industrial purposes. As per the results of the study, the policy aims seem to have materialized, as the diversion has urea completely stopped post the introduction of NCU. In addition to the increase in yield levels of both main product and by-products in all reference crops, farmers have reaped the positive externalities of NCU in terms of increased outputs in respect of all the reference crops, reduced costs (in terms of pest and disease control) and thereby increased returns. All these benefits might not be related to the NCU usage alone as there might be some other favourable reasons that might have contributed to the same as well. However, the usage of NCU relative to NU has not been impressive due to the ignorance of farmers about the potential benefits of NCU over NU and its application. Hence, there is a need for spreading awareness among farmers regarding the NCU usage and its benefits through conducting trainings, organizing demonstrations etc. It is very difficult to realize all the benefits associated NCU, within a limited period (as the study was limited to Kharif 2015). Hence, this can be treated as a baseline survey and can be repeated after few years so as to have a better picture of NCU.

On the other hand, to avoid the adverse impacts of chemical fertilizers on soil health and environment, the Government of India introduced a Soil Health Card Scheme in February, 2015. The main aim of the scheme is to improve the yield levels of crops through a judicious use of fertilizers and to prevent further deterioration of the soil systems through a balanced use of fertilizers based on scientific soil test reports. The SHCs distributed under this scheme contain crop-wise recommendations of nutrients and fertilizers required for plant growth and other characteristics of the soil systems. Based on the secondary information, it is observed that, the targets have been met only in terms of the collection of the soil samples, while progress made in respect of soil testing amounts to only 81 per cent, while in respect of soil health card printing and distribution, the achievement amounts to less than 50 per cent. The low success rate achieved in terms of soil test analysis and printing and distribution of SHCs is mainly due to the lack of infrastructure facilities and manpower requirements at the SDAs and hence, there is a need for addressing these issues immediately. These results also commensurate with the primary survey results of the study, in that hardly less than 35 per cent of the farmers growing reference crops have tested their soil systems. Of them, a very negligible proportion of the farmers has adopted the RDFs based on the soil test. Although they possess SHCs, farmers apply

fertilizers based on their recall" method. Hence, there is a need for creating awareness among the farming community regarding the importance of soil testing, soil health card and adoption of the recommendations. Besides, the field staff should be strengthened with capability building activities and by way of providing better equipments and devices for soil sample collection.

7.4. Policy Suggestions

Policy suggestions have been drawn based on the findings of the study and are presented under the following sub-headings:

Policy Suggestions on NCU

- The increase in crop yield levels of reference crops reflects the potential of NCU use. In order to realize the full potential of NCU, awareness should be created among farmers regarding an optimal use of NCU in order to realize maximum possible yield levels.
- There is a need for re-estimating the recommended doses of fertilizers, while keeping in view the neem-coated urea and its further inclusion in the package of practices.
- There is a need for addressing the concerns voiced by NCU users about its quality, availability, adequacy, timely supply and price through a planning and regulation.
- Special efforts on the part of the government are needed for ensuring a uniform pricing of NCU throughout the country as well as reduction in the price of NCU, as expressed by farmers and other stakeholders.
- The policy of mandatory production and distribution of NCU should be continued as its use helps improve soil health and crop productivity.

Policy Suggestions on SHC Scheme

- Special training programmes/ camps/ demonstrations should be organised by the various stakeholders (SAUs, KVKs, SDAs, Private Companies) as part of educating the farmers regarding soil sampling, benefits of soil testing, balanced use of chemical fertilizers and knowledge about SHC recommendations.
- There is a need for capacity building of the field level staff, required facilities and equipments such as Soil Test Laboratories (STLs), manpower, high quality instruments/devices for a successful implementation of the SHCs Scheme in the sample states.
- A majority of the field level staff have expressed that, the GPS available with the mobile does not work properly due to network and visibility problems during the day, as no GPS

devices have been distributed to them. Hence, they are not able to collect the samples as per the procedures and targets set.

- A majority of the farmers across states and crops have reported delays in the distribution of soil testing reports/ soil health cards as the major problem facing the soil testing programmes, including SHC Scheme. As a result, farmers are more likely to lose their confidence in these programmes. Therefore, timely distribution of SHCs (before sowing season) in hard copy and educating farmers on the information available with SHCs should be promoted for adoption of recommended doses of fertilizers on the basis of soil test reports.
- A majority of the farmers have not treated SHC as an important document when it comes to testing their soil systems. Hence, there is a need for educating the farming community regarding the importance of soil health, benefits of soil testing, cards/ reports, and the information on SHCs, knowledge about SHC recommendations as part of encouraging farmers to make a judicious/ balanced use of chemical fertilizers.
- Gram Panchayats should be involved in undertaking soil testing campaigns on a war footing alongside the department of agriculture for a proper and better implementation of the soil health card scheme.

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9. Appendices

Appendix I: Two Sample Paired t-tests with Unequal variance results for Overall - Paddy

Sl. No.	Variables	Obsn	Mean	Std.Dev	t-values	P-Values
1	Cost of NCU	850	2256.16	4417.07	2.36	0.018
	Cost of NU	328	1662.25	3618.43		
2	Cost of Other fertilizer of NCU	775	12170.48	42590.19	1.78	0.075
	Cost of Other fertilizer of NU	149	17839.48	33938.18		
3	Labour Cost of NCU	826	10127.02	14780.28	2.57	0.011
	Labour Cost of NU	98	17769.57	28961.32		
4	Cost of pest and Disease management NCU	822	8934.09	38266.85	1.94	0.052
	Cost of pest and Disease management NU	139	16012	39817.70		
5	Quantity of Main Product in NCU	849	6739.01	16555.77	2.69	0.007
	Quantity of Main Product in NU	153	10973.49	18092.29		
6	Value of Main product NCU	661	165733.40	327900	0.97	0.32
	Value of Main product NU	124	196813.70	346649		
7	Quantity of By Product of NCU	538	18011.06	43348.80	1.36	0.175
	Quantity of By Product of NU	142	24046.22	47921.76		
8	Value of By-product NCU	538	19676.72	52228.97	0.21	0.827
	Value of By-product NU	142	20493.96	35691.82		
9	Price of main Product of NCU users	661	3084.44	4593.12	3.30	0.001
	Price of main Product of NU users	66	2054.50	2070.60		
10	Price of By-Product of NCU users	137	123.11	310.70	2.11	0.026
	Price of By-Product of NU users	66	89.43	117.44		
11	Total Cost of NCU Users	850	31833	83492.59	2.27	0.023
	Total Cost of NU Users	328	21856	60357.44		

Appendix II: Two Sample Paired t-tests with Unequal variance results for Overall - Tur

Sl. No.	Variables	Obsn	Mean	Std.Dev	t-values	P-Values
1	Cost of NCU	111	825.68	1871.11	1.370	0.172
	Cost of NU	288	1110.73	1835.83		
2	Cost of Other fertilizer of NCU	96	5204.06	8913.85	1.455	0.147
	Cost of Other fertilizer of NU	267	6844.82	10883.83		
3	Labour Cost of NCU	108	5973.611	11235.61	2.587	0.010
	Labour Cost of NU	286	9421.95	13178.80		
4	Cost of pest and Disease management NCU	107	4220.86	9851.12	2.440	0.015
	Cost of pest and Disease management NU	285	7126.14	12062.72		
5	Quantity of Main Product in NCU	110	1096.81	1587.20	0.208	0.834
	Quantity of Main Product in NU	286	1135.28	1779.97		
6	Value of Main product NCU	110	85274.04	128478.9	0.226	0.820
	Value of Main product NU	248	88670.88	145409.7		
7	Quantity of By Product of NCU	94	969.41	1960.86	1.666	0.096
	Quantity of By Product of NU	248	1414.31	2743.92		
8	Value of By-product NCU	95	3179.10	2650.71	3.330	0.001
	Value of By-product NU	247	2036.92	3284.06		
9	Price of main Product of NCU users	26	68880.26	2639.81	1.47	0.144
	Price of main Product of NU users	170	7847.39	5207.14		
10	Price of By-Product of NCU users	26	247.96	151.74	2.473	0.0173
	Price of By-Product of NU users	169	162.71	226.00		
11	Total Cost of NCU Users	111	15207.41	29483.43	2.556	0.0112
	Total Cost of NU Users	288	23864.90	32354.02		

Appendix IIIa: Economic feasibility of NCU in Bihar-Paddy (using partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	---	1	Cost of pest and disease control	22.23
2	Cost of weed management	---	2	Cost of weed management	82.96
3	Cost of NCU	---	3	Cost of NCU	12.66
4	Cost of other items	2098	4	Cost of other items	---
Total added costs		**2098**	**Total reduced costs**		**117.85**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product yield	---	1	Main product yields 2.31 qtls. x Rs.1092.83	2524.43
2	By-product yield	---	2	By-product yield 0.33 qtl. x Rs.192.98	65.66
Total of reduced returns		**---**	**Total of added returns**		**2590.09**
Total (A)		**2098**	**Total (B)**		**2707.94**
B-A		**609.94**			

Note: Additional return from NCU is about Rs.609.94 per acre

An added return per acre is Rs. 2707.94

Benefit Cost Ratio B:C Ratio= B/A=1.29

Appendix IIIb: Economic feasibility of NCU in Assam-Paddy (using partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	---	1	Cost of pest and disease control	22
2	Cost of weed management	---	2	Cost of weed management	38
3	Cost of NCU	---	3	Cost of NCU	76
4	Cost of other items	---	4	Cost of other items	219
Total added costs		**0**	**Total reduced costs**		**355**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product yield	---	1	Main product yields	796
2	By-product yield	---	2	By-product yield	161
Total of reduced returns		**---**	**Total of added returns**		**957**
Total (A)		**0**	**Total (B)**		**1312**
B-A		**1312**			

Note: Additional return from NCU is about Rs.1312 per acre

An added return per acre is Rs.1312

Appendix IIIc: Economic feasibility of NCU in Karnataka-Paddy (using a partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	-	1	Cost of pest and disease control	167
2	Cost of weed management	-	2	Cost of weed management	17
3	Cost of NCU	-	3	Cost of NCU	23
4	Cost of other fertilizers	1201	4	Cost of other fertilizers	-
Total added Costs		**1201**	**Total Reduced cost**		**207**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	-	1	Main product 2.83 quintal x 1804.35	5106
2	By-product yield	-	2	By-product yield 2.08 quintal x 84.15	175
Total of reduced return		**-**	**Total of added returns**		**5281**
Total (A)		**1201**	**Total (B)**		**5489**
B-A		**4288**			

Note: Additional return from NCU is about Rs.4287.73/- per acre

An added return per acre is Rs.5488.82

Benefit Cost Ratio B:C Ratio= B/A=4.56

Appendix IIId: Economic feasibility of NCU in Madhya Pradesh - Paddy (using a partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Ploughing and sowing charges (only machinery)	84	1	Other chemical fertilizers	26
2	Seed cost/ purchase of seedlings	339			
3	Organic/ FYM	10			
4	Urea/ NCU	27			
5	PPC	48			
6	Irrigation Charges	10			
7	Harvesting and Threshing charges	123			
8	Hired labour charges	33			
9	Imputed value of family labour	45			
10	Hired labour charges	260			
11	Maintenance costs	164			
Total added costs		**1142**	**Total reduced costs**		**26**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
		---	1	Gross returns	2517
Total (A)		**1401**	**Total (B)**		**2543**
B-A		**1142**			

Note: Return per Rupee Investment: 1.23

Appendix IIIe: Economic feasibility of NCU in Punjab-Paddy (using a partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Ploughing charges till planting	67	1	Cost of sowing/ transplantation	86
2	Seed cost/ purchase of seedlings	18	2	Organic/ Bio-fertilizers/ FYM/ City Compost/ Neem Cake	245
3	NCU	90	3	Irrigation Cost	87
4	Cost of other fertilizers	25	4	Pesticides/ Insecticides	236
5	Harvesting	18	5	Weedicides	24
6	Hired labour charges	2	6	Labour cost Own	33
7	Maintenance costs	106		-	-
Total added costs		**326**	**Total reduced costs**		**711**
Net Cost reduction			**711 - 326 = Rs.385**		
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
	-	-	1	Gross returns	333
		---	2	-	-
Total (A)		**326**	**Total (B)**		**1044**
B-A		**718**			

Note: Additional return from NCU is about Rs.333/- per acre

An added return per acre is Rs. 718

Benefit Cost Ratio B:C Ratio= B/A=3.20

Appendix IV a: Economic feasibility of NCU in Karnataka-tur (using a partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	-	1	Cost of pest and disease control	3
2	Cost of weed management	536	2	Cost of weed management	-
3	Cost of NCU	66	3	Cost of NCU	-
4	Cost of other fertilizers	1364	4	Cost of other fertilizers	-
Total added Costs		**1966**	**Total Reduced cost**		**3**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	305	1	Main product	-
2	By-product	16	2	By-product yield	-
Total of reduced return		**321**	**Total of added returns**		**-**
Total (A)		**2287**	**Total (B)**		**3**
B-A		**Rs. -2284**			

Note: Additional return from NCU is about Rs. - 2284/- per acre

An added return per acre is Nil

Benefit Cost Ratio B:C Ratio= B/A= Nil

Appendix IV b: Economic feasibility of NCU in Maharashtra-Tur (using a partial budgeting framework)

(Per acre)

A			B		
Sl. No.	Added cost due to NCU	Costs (Rs.)	Sl. No.	Reduced cost due to NCU	Returns (Rs.)
1	Cost of pest and disease control	139	1	Cost of pest and disease control	-
2	Cost of weed management	64	2	Cost of weed management	-
3	Cost of total urea	32	3	Cost of NCU	-
4	Cost of other fertilizers	260	4	Cost of other fertilizers	-
5	Cost of micro-nutrients	43	5	-	-
Total added Costs		**538**	**Total Reduced cost**		**0**
Sl. No.	**Reduced return due to NCU**	**Costs (Rs.)**	**Sl. No.**	**Added returns due to NCU**	**Returns (Rs.)**
1	Main product	-	1	Main product	15853
2	By-product yield	-	2	By-product yield	705
Total of reduced return		**-**	**Total of added returns**		**16558**
Total (A)		**538**	**Total (B)**		**16558**
B-A		**Rs. 16020**			

Note: Additional return from NCU is about Rs.- 16020/- per acre

An added return per acre is 16558

Benefit Cost Ratio B:C Ratio= B/A= 30.81

Farmers showing their Soil Heath Cards at the time of data collection in the sample areas

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